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SPECIAL REPORT

OF THE

County Medical Officer of Health

ON THE

OUTBREAK OF SMALLPOX

IN THE

BOROUGH OF MIDDLETON

IN 1920.

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Special Report of the County Medical Officer of Health on the Outbreak of Smallpox in the Borough of Middleton in 1920.

The Medical Officer of Health of the Borough of Middleton informed me by letter, dated the 23rd August, 1920, that he had received on the 21st August two notifications of cases of smallpox. I instructed Dr. Fisher, Chief Assistant County Medical Officer of Health, to investigate the circumstances of the outbreak, and he visited Middleton on the 25th August. He interviewed Dr. Ball, the Medical Officer of Health, and obtained particulars with regard to the cases, and accompanied the Medical Officer to the Ashton-under-Lyne and District Smallpox Hospital at Hartshead Pike, to which the cases had been removed.

The circumstances of the outbreak, as communicated by the Medical Officer of Health, were as follow :—

E.A., aged 39 years, and her son, F.A., aged 15 years, were notified as suffering from smallpox on the 21st August, 1920. On the same day they were removed to the Ashton-under-Lyne and District Smallpox Hospital at Hartshead Pike. On investigation it was found that the source of infection was another member of the family (A.A.), a girl aged 13 years. About the end of July this girl was ill and developed a rash, which was considered to be chicken-pox. The occupants of the affected house consisted of nine persons—the mother, seven children, and the mother's aunt. Six of the occupants had been vaccinated in infancy and possessed satisfactory vaccination scars, and they escaped smallpox ; the remaining three occupants, two of whom (F.A. and A.A.) were unvaccinated, and one (E.A.) said to have been vaccinated in infancy, but showing no vaccination scars, developed the disease.

In connection with this outbreak I received a communication from the Medical Officer of Health of the City of Manchester that cases of smallpox had been notified in the Blackley district of that City, which area adjoins the Rhodes portion of the Borough of Middleton.

On investigation it was found that the first Middleton case developed the disease about the same time as the first Manchester case, and that they both worked at the same cotton mill in Middleton. Other secondary cases were notified in Blackley. The details of this outbreak will be dealt with in connection with the description of the main epidemic which occurred later.

No further cases were notified until 5th October, when I received a communication from the Medical Officer of Health of Middleton, stating that a girl, aged 17 years, had been notified as suffering from smallpox, and on the 11th October he forwarded particulars of seven other notifications. On the 13th October I received a telephonic communication, asking me to co-operate in dealing with the epidemic, and I visited the district on the following day. After making inquiries, I formed the opinion that the disease had obtained an extensive hold in the borough. Cases were occurring very rapidly, and up to and including the 15th October, 27 notifications were received by the Medical Officer of Health. In addition, the visitation and supervision of the increasing number of contacts were becoming too great a task for the local staff to deal with.

Middleton is a municipal borough situated in the centre of the most densely populated portion of the County, and is surrounded by the following districts :—The City of Manchester, Chadderton, Oldham (C.B.), Royton, Crompton, Rochdale (C.B.), Heywood (B.), Whitefield, Prestwich, Salford (C.B.), Milnrow, Bury (R.), and Failsworth, the total population of these areas being approximately 1,344,325. According to the 1911 Census, the population of Middleton was 27,983, and the provisional figures for the 1921 Census give the population as 28,309. The number of houses in the borough is 7,085.

The borough is bounded on the north by Heywood (B.) and Rochdale (C.B.), on the south by the City of Manchester, on the east by Chadderton and Royton Urban Districts, and on the west by Prestwich Urban District and the Unsworth portion of the Bury Rural District. It is situated about 6 miles north of Manchester, 5 miles south of Rochdale, and 4 miles west of Oldham, and is connected with each of these towns by a service of tramcars; it is also the terminus of a branch line of the

Lancashire and Yorkshire Railway. The chief industries are cotton spinning, weaving, bleaching, dyeing, and finishing. It is a very busy industrial centre, containing many large mills and other works, which employ workers from adjoining districts. A number of the population of Middleton also work in Manchester, Oldham, and Chadderton. The central ward of the borough is the most densely populated, containing, according to the 1911 Census, an average of 32·6 persons per acre.

It was obvious, therefore, that every effort should be made to limit the spread of the disease, and on the 14th October I instructed Dr. Fisher and the following Assistant County Medical Officers of Health to proceed to Middleton :—Dr. Ash, Dr. Scholefield, Dr. Walker, and Dr. Wright; also the County Sanitary Officers, Messrs. Eginton, Keeley, Mason, and Mercer, and two members of the clerical staff, Messrs. Platts and Pearson. Each member of the County staff was revaccinated before taking up work in the borough.

ADMINISTRATION.

For the purpose of investigating and controlling the epidemic the following administrative measures were adopted by the Local Sanitary Authority :—

Provision of adequate Hospital Accommodation.—The first cases notified were removed to the Ashton-under-Lyne and District Joint Smallpox Hospital at Hartshead Pike, where there is accommodation for 12 patients. It was soon found necessary to increase the hospital accommodation, and the Chadderton, Crompton and Royton Joint Smallpox Hospital at Racefield, which in inter-epidemic periods is used for the treatment of pulmonary tuberculosis, was vacated by the tuberculosis cases on the 14th October; this hospital has accommodation for 26 patients. On the 4th November additional accommodation was required, and, at the request of the Ministry of Health, the Manchester Corporation kindly placed beds at the disposal of the Borough of Middleton at their Smallpox Hospital at Clayton Vale, and 17 patients were treated there.

Removal to Hospital of Patients suffering from the Disease.—In the early part of the epidemic, the patients were removed to hospital by means of a horse ambulance, but later the Authority purchased a motor ambulance. Motor transport was a great advantage, as it not only allowed a source of infection to be rapidly removed, but made it possible for all cases to be admitted to hospital on the day of notification.

Disinfection.—The Local Authority possess a steam disinfector, where all infected materials were disinfected. Contacts from infected dwellings were also dealt with at the disinfecting station. Overalls were provided for the staff employed on the ambulance and disinfecting services.

Vaccination or re-vaccination of the sanitary staff engaged on smallpox work, viz : ambulance driver, disinfecting staff, &c.

Public Vaccinators, Vaccination Officer, and General Practitioners were kept acquainted with the developments of the epidemic.

The Infectious Disease (Notification) Act, 1889, was extended to include chicken-pox.

Closure of schools on the 18th and 19th October. The period of closure extended to eleven weeks. Sunday schools were voluntarily closed, and social gatherings abandoned.

Common lodging-house keepers and the heads of institutions were informed of the occurrence of smallpox in the borough. Managers of picture houses were requested to exclude children under 14 years from the performances.

Posters and handbills drawing attention to the prevalence of smallpox and pointing out the value of vaccination as a protective measure against the disease were placarded and distributed throughout the borough. Notices were also inserted in the local newspaper.

Arrangements were made for the feeding of contacts in the affected houses.

The administrative measures carried out by the County Staff, in close co-operation with the Medical Officer of Health, included the following :—

Areas.—The borough was divided into four areas, and each area was allocated to a County Sanitary Officer, who was responsible for the visiting of contacts, absentees from mills, works, &c. This division of the borough into areas was essential to prevent overlapping, as in the majority of the notified cases the addresses of the contacts were scattered over a wide area. The division was also an advantage, as it not only enabled the Sanitary Officer to work in a compact area, but also gave him the opportunity to gain an intimate knowledge of the conditions of the district allotted to him.

Contacts.—A list of the contacts in each area was compiled as follows :—On the occurrence of a case of smallpox, one of the County Sanitary Officers visited the home of the patient and, if possible, questioned the patient and other inmates of the house, by this means compiling as complete a list as possible of contacts under four headings, viz., (1) intimate contacts living in the same house, (2) persons visiting the house such as tradespeople, milkman, insurance collectors, &c., (3) persons who had been in contact with the patient outside the house, including fellow workmen, and (4) all relatives living in the town whether there was a history of contact or not. Information was obtained as to the date and place of contact, state of vaccination, occupation of contacts, and where employed. Special enquiries were made as to the possibility of infected articles having been sent to laundries or pawnshops. These particulars were recorded on a contact form, which was returned to the Central Office, and the information was immediately transferred to the district visiting sheets. By this means it was possible to obtain a list of contacts in street order, thereby facilitating the work of keeping the contacts under observation. All contacts were kept under supervision for a period of 16 days by the County Sanitary Officers, and if any of the contacts or persons living in the same house developed signs of illness, the information was immediately forwarded by the Sanitary Officer to the Central Office, and a Medical Officer subsequently paid a visit to the house. Any particulars obtained with regard to contacts residing outside the Borough of Middleton were immediately communicated, either by telephone or letter, to the Medical Officer of Health of the district concerned.

A daily visit was paid to the five common lodging-houses in the borough by a Sanitary Officer. Any case of illness occurring amongst the inmates was reported to the Central Office, and a Medical Officer then visited the premises and examined the patient.

The following is a summary of the number of visits paid to contacts :—

Area No. 1	1,776
Area No. 2	2,627
Area No. 3	3,360
Area No. 4	813
	8,576
Special Visits ...	257

A number of cases were notified in children attending the Durnford Street School, one of the largest schools in the borough, with an average attendance of 560 children. The addresses of these children were arranged in street order, and a house-to-house visitation was carried out, with a view to the discovery of missed cases. Several cases were discovered by this means. The school nurses carried out this work, and informed the medical staff of cases requiring examination. In addition, a house-to-house visitation of infected areas was undertaken.

Cases.—On receipt of the notification of a case, or information of a suspected case of smallpox, the Medical Officer of Health, usually accompanied by one of the Assistant County Medical Officers, visited the house, and the diagnosis was confirmed or otherwise. The medical history of the case was recorded on a case form, which was immediately returned to the Central Office for the information to be tabulated. A list of all cases notified, giving the number of the case for record purposes, name, address, age, sex, vaccination history, date of onset of the disease, date of the rash, date of notification and removal to hospital, and if employed, where engaged and the nature of occupation, &c., was accessible to all the members of the staff engaged in the epidemic, thus enabling them to keep in close touch with the trend of events. A spot map showing the position of the house where each case occurred was also available for reference.

Vaccination.—The administration of the vaccination laws rests with the Board of Guardians, the local register of vaccinations being kept by the Vaccination Officer, and the vaccinations performed by the Public Vaccinator. On the occurrence of smallpox a Medical Officer of Health is empowered to vaccinate immediate contacts of smallpox patients under the terms of the Public Health (Smallpox Prevention) Regulations, 1917. The Assistant County Medical Officer on his visit to a house where a case of smallpox had occurred, in addition to obtaining information as to the medical history of the case, offered vaccination to all the inmates. This was found from experience to be the time when contacts were most willing to accept vaccination. As the greater portion of the population had not been vaccinated since infancy, an active propaganda in favour of vaccination was undertaken. In addition, house-to-house visits were made in the neighbourhood of each dwelling in which smallpox occurred, and particular attention was given to all shops in the immediate neighbourhood, and the shopkeepers strongly advised to accept vaccination. This course was taken as several cases were notified as occurring in shops, which resulted in complete disorganisation of the business, and a large amount of work for the sanitary staff. In the event of a case of smallpox occurring amongst the employees of a mill or other works, a communication was forwarded to the manager, giving the name of the patient, and also the names of the persons who had been in close contact with the case at work. The Medical Officer of Health arranged for many of the mills and works to furnish a list of the names and addresses of their employees. These were useful in compiling a list of contacts when a case was notified.

Vaccination centres were opened at some of the larger mills and works with the consent of the management. One of the Assistant County Medical Officers attended and offered free vaccination to the workers who had been in contact with cases. As the number of persons presenting themselves for vaccination increased, it was found necessary to augment the staff, and I instructed Dr. Hall, Dr. Jagger and Dr. Tomb, Assistant County Medical Officers of Health, to assist in this work. Additional vaccination centres were opened from 7 to 8 o'clock in the evening in two areas of the borough, and Dr. Tomb and Nurse Dickinson assisted at these centres. The work involved in re-dressing the vaccinations performed by the Medical Officers and in the daily visiting of the increasing number of contacts became very heavy, and I instructed Nurse Rochell and Nurse Smith to help in this work. The School Clinic was opened as a vaccination and re-dressing centre. The premises were also used as an office, and provided excellent accommodation for the medical and clerical sides of the work. The lymph used for the vaccinations was obtained from the Government Lymph Establishment, Colindale Avenue, The Hyde, N.W. 9. It is essential that an adequate supply of lymph should be available, and all demands for lymph were promptly met by the Government Lymph Establishment. It is difficult during an epidemic to estimate the amount of lymph required on any particular day, and a certain amount remained unused, as the Government Lymph Establishment requests that all tubes which have been in the possession of a Medical Officer for a longer period than seven days should be returned. All vaccinations performed by the Assistant County Medical Officers were recorded as required by the Public Health (Smallpox Prevention) Regulations, 1917, and the results of the vaccinations were classified and forwarded to the Government Lymph Establishment. In the case of primary vaccinations, the statutory certificate of successful vaccination was forwarded to the Vaccination Officer as required by the Vaccination Acts, 1867 to 1898. This involved a considerable amount of clerical work.

Arrangements were made with the managers of mills and works where cases of smallpox had occurred for a daily list of absentees from work to be supplied to the Central Office. These were allocated to the areas in which the addresses were situated, and visited by the Sanitary Officers to ascertain the reason for absence from work. All names and addresses of absentees from work living outside Middleton were communicated to the Medical Officer of Health of the district where the absentee resided.

INTELLIGENCE WORK.—In dealing with this epidemic, an important section of the administration was what may be termed the intelligence department.

When a case was notified and the diagnosis had been confirmed, every effort was made to trace the source of infection, and investigations were carried out on the following lines :—

> The Medical Officer, on his visit to the affected house, made careful enquiries as to the movements of the patient on or about the fourteenth day prior to the first appearance of the rash, the date of the appearance of the rash being the most reliable date. The patient was questioned as to his knowledge of cases which had been previously notified, and it was found to be a useful procedure to read to the patient a list of the names of the cases.
>
> The patient was questioned as to his or her knowledge of cases of supposed chicken-pox. In one instance, six cases of smallpox were discovered by this means. The possibility of a missed case being the cause of infection was investigated in each instance.
>
> All the persons living in the affected house were examined, and by this procedure several cases were discovered. From experience gained during the epidemic, it was found advisable to place the names of all the relatives living in the borough on the contact lists, whether there was a history of contact or not.
>
> The general practitioners in the borough rendered every assistance, especially by giving facilities for the examination of their patients.
>
> In carrying out the vaccinations, the Assistant County Medical Officers examined all persons exhibiting rashes and skin lesions.
>
> Where a vaccination and re-vaccination showed a negative result, the individual was carefully examined, and on several occasions signs of present or past smallpox were discovered.
>
> A number of concealed cases were brought to light as the result of careful enquiry and investigation, and three convictions in the local police court, on the grounds of concealment of the disease, were obtained.

Each member of the staff recorded the result of his enquiries by the above methods. The information obtained was collected and examined, and by this means the source of the infection in the majority of the cases was discovered, and an almost complete history of the epidemic compiled. These methods also enabled the staff to anticipate in many instances where new cases were likely to occur, and thus ensure their early diagnosis and removal to hospital.

Office Accommodation.—In an epidemic of this extent it is necessary to provide adequate office accommodation and an efficient clerical staff. All information reported to the office was immediately available for reference. In this outbreak a senior and junior clerk were fully employed.

Table I.

The following table gives particulars of each case occurring during the epidemic :—

No.	Initials of Patient.	Age.	Sex.	Vaccinal condition		Date of		Days in Hospital.
				Vacc.	Unvacc.	Onset.	Rash.	
						1920	1920	
1	A.A.	13	F.	...	x	?29 July	31 July	*
2	E.A.	39	F.	...	x	16 Aug.	21 Aug.	33
3	F.A.	15	M.	...	x	17 Aug.	21 Aug.	33
4	W.W.	17	F.	...	x	28 Sept.	2 Oct.	42
5	F.C.	18	M.	...	x	28 Sept.	3 Oct.	29
6	A.B.	11	F.	...	x	5 Oct.	8 Oct.	44
7	F.B.	10	M.	...	x	2 Oct.	6 Oct.	44
8	A.B.	8	M.	...	x	4 Oct.	8 Oct.	28
9	B.T.	10	F.	...	x	4 Oct.	7 Oct.	36
10	E.H.	10	F.	...	x	5 Oct.	9 Oct.	43
11	E.P.	10	F.	...	x	4 Oct.	10 Oct.	36
12	C.D.	11	M.	...	x	6 Oct.	12 Oct.	47
13	A.R.	10	F.	...	x	?16 Sept.	24 Sept.	20
14	E.S.	7	F.	...	x	8 Oct.	12 Oct.	49
15	M.W.	11	F.	...	x	6 Oct.	12 Oct.	41

Table I.—continued.

No.	Initials of Patient.	Age.	Sex.	Vaccinal condition.		Date of		Days in Hospital.
				Vacc.	Unvacc.	Onset.	Rash.	
						1920	1920	
16	N.I.	9	F.	...	x	5 Oct.	10 Oct.	41
17	N.B.	5	F.	...	‡	4 Oct.	9 Oct.	54
18	R.C.	10	M.	...	x	9 Oct.	12 Oct.	54
19	B.T.	61	F.	Infancy	...	6 Oct.	10 Oct.	29
20	J.H.	53	F.	Infancy	...	3 Oct.	10 Oct.	36
21	D.P.	11	F.	...	x	8 Oct.	13 Oct.	49
22	C.M.G.	10	F.	Infancy	...	7 Oct.	11 Oct.	36
23	M.H.D.	10	F.	...	x	9 Oct.	11 Oct.	42
24	E.R.	13	F.	...	x	10 Oct.	14 Oct.	35
25	J.W.	10	M.	...	x	10 Oct.	14 Oct.	40
26	N.T.	11	F.	...	x	8 Oct.	14 Oct.	35
27	A.T.	25	F.	...	x	11 Oct.	14 Oct.	54
28	J.R.	8	F.	...	x	5 Oct.	12 Oct.	27
29	E.W.	33	F.	Infancy	...	13 Oct.	15 Oct.	19
30	E.H.	7	F.	...	x	11 Oct.	13 Oct.	53
31	H.E.	12	M.	...	x	6-8 Oct.	13 Oct.	50
32	R.W.	13½	M.	...	‡	16 Oct.	18 Oct.	43
33	J.W.	7	F.	...	‡	15 Oct.	17 Oct.	50
34	M.W.	41	F.	...	‡	18 Oct.	20 Oct.	13
35	J.B.W.	43	M.	†Infancy	...	17 Oct.	19 Oct.	29
36	E.I.	12	F.	...	‡	21 Oct.	23 Oct.	45
37	N.W.	10	F.	...	‡	20 Oct.	23 Oct.	41
38	E.T.	6	F.	...	‡	22 Oct.	24 Oct.	36
39	L.A.	47	F.	Infancy	...	22 Oct.	25 Oct.	25
40	J.T.B.	45	M.	†Infancy	...	20 Oct.	24 Oct.	25
41	E.H.	18	F.	...	‡	23 Oct.	25 Oct.	35
42	R.T.	49	M.	Infancy	...	21 Oct.	24 Oct.	42
43	M.E.	41	F.	...	x	22 Oct.	26 Oct.	43
44	F.T.	12	F.	...	‡	25 Oct.	27 Oct.	48
45	A.H.	11½	F.	...	x	23 Oct.	27 Oct.	52
46	A.P.	9	F.	...	x	22 Oct.	24 or 26 Oct.	38
47	E.H.	5	F.	...	‡	23 Oct.	26 Oct.	28
48	J.H.	7	M.	...	‡	24 Oct.	27 Oct.	28
49	L.M.	8	F.	...	x	21 Oct.	25 Oct.	40
50	G.P.	9	F.	...	‡	25 Oct.	28 Oct.	40
51	J.H.	63	M.	†Infancy	...	26 Oct.	28 Oct.	46
52	R.J.	70	M.	...	x	25 Oct.	30 Oct.	73
53	W.C.	5	M.	...	‡	25 or 26 Oct.	30 Oct.	45
54	E.McM.	2½	F.	...	x	?10 Oct.	?	33
55	J.W.McM.	7	M.	...	x	29 Oct.	31 Oct.	33
56	E. McM.	25	F.	...	x	Indefinite	31 Oct.	43
57	E.W.	61	F.	Infancy	...	26 Oct.	30 Oct.	47
58	T.S.	11	M.	...	x	Indefinite	18 Oct.	59
59	E.S.	17	M.	...	x	27 Oct.	1 Nov.	43
60	R.S.	5	M.	...	x	26-29 Oct.	1 Nov.	47
61	G.W.	7	F.	...	x	31 Oct.	3 Nov.	57
62	F.M.	25	F.	...	x	31 Oct.	3 Nov.	22
63	W.B.	50	M.	Infancy	...	29 Oct.	3 Nov.	34
64	H.B.	13	F.	...	x	29 Oct.	4 Nov.	36
65	E.B.	20	F.	...	x	1 Nov.	6 Nov.	35
66	N.S.	7	F.	...	x	6 Nov.	10 Nov.	26
67	J.S.	10	M.	...	x	8 Nov.	11 Nov.	26
68	J.N.	43	M.	...	x	8 Nov.	12 Nov.	39
69	H.R.	4	F.	...	‡	13 Nov.	16 Nov.	35
70	F.N.	9	F.	...	‡	12 Nov.	17 Nov.	20
71	H.E.	8	M.	...	x	29 Oct.	1-2 Nov.	44
72	A.E.	3	F.	...	x	?	14-15 Nov.	44
73	A.E.	42	F.	Infancy	...	?	15 Nov.	44
74	L.E.	5	F.	...	x	?	16 Nov.	44

Table I.—continued.

No.	Initials of Patient.	Age.	Sex.	Vaccinal condition.		Date of		Days in Hospital.
				Vacc.	Unvacc	Onset.	Rash.	
						1920	1920	
75	J.E.	47	M.	Infancy	...	13 Nov.	16 Nov.	35
76	A.E.	15	F.	Infancy	...	12 or 13 Nov.	16 or 17 Nov.	19
77	E.B.	46	F.	Infancy	...	13 Nov.	18 Nov.	25
78	E.H.	11	F.	...	x	16 Nov.	20 Nov.	28
79	C.S.	34	F.	...	‡	16 Nov.	21 Nov.	14
80	K.N.	40	F.	†Infancy	...	15 Nov.	21 Nov.	14
81	A.C.	8	F.	...	‡	19 Nov.	22 Nov.	31
82	L.N.	5	F.	...	x	20 Oct.	24. Oct.	*
83	C.D.	55	M.	Infancy	...	19 Nov.	24 Nov.	28

* Unrecognised case, not removed.
† Re-vaccinated after third day of incubation period.
‡ Primarily vaccinated after third day of incubation period.
x Unvaccinated.

Cases removed to the following hospitals :—

Ashton-under-Lyne and District Smallpox Hospital, Hartshead Pike	12
Chadderton, Crompton and Royton Smallpox Hospital, Racefield	52
Manchester Corporation Hospital, Clayton Vale	17
Unrecognised cases, not removed	2
	83

Dr. Scholefield has plotted the cases which occurred between September 28th and November 26th on Chart A (see Appendix.) The abscissæ indicate days and the ordinates cases :—

Curve (*a*) gives a daily record of the number of cases showing the first signs of the rash.

Curve (*b*) gives a daily record of the number of notifications received.

Curve (*c*) ,, ,, cases removed to hospital.

It will be seen from the chart that from October 16th onwards, removals to hospital coincided with the date of notification, but it is not until the end of the fifth week that a close relationship is found between the curve of the appearance of the rash and the curves of notification and removal to hospital. After the fifth week, however, the curves begin to resemble one another. This indicates that administrative control of the outbreak was obtained at the end of five weeks. The chart shows that there were three main waves in the incidence of cases at intervals of about two-and-a-half weeks. The fourth wave would have been due by December 6th, but this did not occur in Middleton, but it is interesting to note that on this date four cases were notified in the neighbouring County Borough of Oldham. An effort was made to trace the infection from cases in Middleton to those occurring in Oldham, but without success. The outbreak in Oldham was limited to a few cases.

Dr. Scholefield also carried out investigations on the infectivity of the disease. He made inquiries in 19 houses where smallpox had occurred, and reports as follows :—

> " In 19 houses there were 57 cases of smallpox, and from these a careful selection was made of the cases where there appeared to be good evidence that the infection had been derived from a primary case in the household, and not from an outside source. In this way I obtained a series of 26 secondary cases from 13 primary sources. It was found that the onset of these 26 secondary cases was on the average 18·5 days after the onset in the primary cases, but the variation was somewhat large, the lowest being 13 days and the highest 26 days. If it be assumed that the incubation period is 12 days, then the most usual time for infection with this type of the disease is about the end of the first week or about the fourth day of the rash. In practice it was found that where the case was removed and the contacts vaccinated before the fourth day of the rash, the risk of spread of the disease from that source was very small."

DESCRIPTION OF THE EPIDEMIC.

As a result of the investigations and evidence collected by the various members of the staff, the Diagram B has been prepared (see Appendix). Each case is represented by a small circle coloured red or green, which contains the case number and the date of onset of the disease. The circles coloured red indicate cases which were notified as smallpox, and the circles coloured green represent missed cases which were not notified but in which there was strong evidence that the persons had suffered from smallpox. The firm lines connecting the circles indicate that definite evidence was obtained that the cases were connected, the dotted lines that the evidence was not conclusive but very suggestive of a connection. The large circle coloured yellow in the centre of the diagram represents the buildings of one of the largest schools in the town, namely the Durnford Street school, with accommodation for 1,002 children and an average attendance of 560. The radii of the circle show the various divisions of the building into classrooms and departments. The arrow pointing to the centre of the school from Case 13 indicates the source from which the disease was introduced into the school. The cases occurring in the school are included in the large circle, and are placed in the department or classrooms in which they occurred. At the right hand top corner of the diagram the cases notified in Manchester are indicated by red circles, and the cases which occurred in Crewe are shown in blue.

For the purpose of describing the epidemic, the borough can be divided into three geographical areas, namely :—

> *No. 1 Area.*—The detached portion of the borough called Rhodes, and locally known as Rhodes village. This area is connected by tramcar to the centre of the borough, and is in close proximity to the Blackley district of Manchester.
>
> *No. 2 Area.*—The main portion of the town, which contains the Durnford Street school and the majority of the large mills and works.
>
> *No. 3 Area.*—The district known as Middleton Junction, which adjoins the Chadderton Urban District.

As mentioned previously, in the first outbreak the first Middleton case (A.A.) and the first Manchester case (M.A.B.) developed the disease on the same day, and probably derived the infection from a common source—they both worked at the Neva Mill, situated in Middleton. A.A. worked in Room 1 as a little tenter, and M.A.B. was employed in Room 2 as a card tenter. The question naturally arose as to the source of infection in these two cases, and whether the cotton which these girls handled in the course of their work might have been the source. The evidence that cotton was the carrier of infection appeared to be unsatisfactory. Only two cases arose which could have any connection with this source, and these two cases worked in different departments of the mill. Under these circumstances, every effort was made to find evidence of a missed case, and the following facts lend some support to this view :—

The first Manchester case, M.A.B., a native of Crewe, developed the preliminary illness of smallpox on July 26th, and on July 29th and 30th spots appeared on her face and arms. She was married on July 31st to a member of a family called M., with whom she lodged in the Blackley district of Manchester. Her relatives from Crewe attended the wedding ceremony and stayed in the house until August 3rd, and developed smallpox in Crewe about 12 days later, and it was only when these cases were notified that the true nature of the disease of the case M.A.B. in Blackley was recognised. It is obvious, therefore, that the opportunities for the spread of the disease in Blackley were great, as the patient was not removed to hospital until late on in the period of the disease. Two of the M. family (A.M. and C.M.) contracted the disease from M.A.B. After her discharge from hospital, and when she had returned to work at the Neva Mill, one of the members of my staff interviewed M.A.B. and her sister-in-law, E.M., one of the M. family who also worked at the same mill. He found that M.A.B. showed very marked staining, on the arms especially, so that the rash must have been fairly copious. On questioning E.M., she stated that L.B., a sister of M.A.B., came from Crewe to Blackley on or about the 16th June, 1920, for a holiday " to pick up after 'flu." The question arises as to whether this so-called influenza was in reality a mild attack of smallpox, and if this was not a possible means by which the disease came to Blackley.

The vaccination history of the M. family and of M.A.B. and L.B. is interesting in this connection :—

	Age.	Vaccination history previous to present outbreak of smallpox.	Vaccination history during the outbreak of smallpox.	Result.
Mr. C.M.	62	Repeatedly vaccinated, as recently as 1916	Refused re-vaccination	...
Mrs. F.M.	52	Infancy vaccination ? No marks	Re-vaccinated	Did not take
E.M.	17	Do. do.	Do.	Do.
L.B.	8	Vaccinated in infancy, one mark only	Do.	Do.
M.A.Br.	18	Infancy vaccination ? No marks	Do.	Do.
Alf. M.	24	Infancy vaccination ? Re-vaccinated in Army	Refused re-vaccination	...
A.M.	18	Infancy vaccination ? No marks	Case of smallpox	...
C.M.	14	Vaccinated in infancy, one poor mark	Case of smallpox	...
M.A.Be.	24	Infancy vaccination ? No marks	Case of smallpox	...

Certain guests who attended the wedding ceremony were vaccinated successfully.

In view of the fact that over 98 per cent. of the vaccinations, both primary and re-vaccinations, carried out during the epidemic were successful, it is interesting to observe that four members of the above household exhibited a negative reaction to vaccination, and raises the possibility that there were one or more missed cases in this household. It is therefore possible that E.M., one of the M. family, who, as previously stated, worked at the Neva Mill, was the source of the infection in the first Middleton and Manchester cases. She was an acquaintance of A.A., the first Middleton case. A.A. infected her mother and brother, Cases Nos. 2 and 3 on the diagram. Case E., coloured green on the diagram, was a sister of A.A., Case 1, and slept with her. She developed all the symptoms of the preliminary illness of smallpox, but no signs of the rash were discovered. Two attempts were made to vaccinate this case, but showed negative results although she had not been previously vaccinated.

As mentioned at an earlier stage in the report, no fresh cases were notified for a period of about six weeks, when the main part of the epidemic commenced. At the beginning of the fresh outbreak, and for some time afterwards, a close and exhaustive search failed to connect the first Middleton cases with the main epidemic. Contacts, playmates, and friends of the first cases were questioned, and investigations carried out with a negative result. It was not until late in November that evidence was obtained by one of my medical staff which leads me to conclude that there was a possible connection between the original cases in Blackley and the main group of the Middleton cases.

Cases 4 and 5, the first cases in the main outbreak in Middleton, appeared from the dates of onset to have a common source of infection. It was found that they worked in different cotton mills, but for a long time no further clue was discovered. Eventually, however, it was found that they had been very friendly since the summer wakes. Both of them had some connection with Blackley, Case 4 a very close and constant connection. Case 5 admitted having actually visited the shop of the M. family, mentioned previously, at Blackley on 17th September. The family of Case 4 were originally a Blackley family, and the mother admitted that she had known the M. family very well for over 10 years. Cases 4 and 5 were at Blackley together on the 11th and 12th December, and there is evidence that Case 4 visited Blackley regularly every week-end. Case 4 admitted being in Blackley for the week-end a fortnight before the onset of her illness, and admitted that she might have been in the shop of the M. family on that occasion. The Rhodes portion of Middleton is only a short walk by means of a footpath from Blackley. The inference can therefore be drawn that Blackley people visit Rhodes, and the evidence is very strong that certain Blackley people visited the house where Case 4 lived. In the opinion of my medical staff, there was amongst these friends of Case 4 coming from Blackley a missed case. This missed case was probably the cause of the outbreak of the disease in Rhodes, and it is seen from the diagram that Cases 4, 5, 17 and 13 probably derived their infection from this missed case. From an inspection of the dates of onset of the cases, it is probable that this missed case visited Rhodes on more than one occasion. Case 13 (A.R.), a child attending the Durnford Street school in Middleton, did not live in Rhodes, but went there twice weekly to visit her grandmother, who lived in Rhodes, to receive attention to her hair. Case 13 (A.R.) stated that Case 17 (N.B.) was a playmate of one of the members of the family of Case 4, and there is abundant evidence from other sources that this information was correct. Thus Cases 4 and 17 probably had a common source of infection.

Case 4 (W.W.) gave the disease to several members in her own household, namely, Cases 32 (R.W.), 33 (J.W.), 34 (M.W.), 35 (J.B.W.) and 37 (N.W.). Case 13 gave the disease to three others in Rhodes, namely, Cases 14 (E.S.), 19 (B.T.) and 27 (A.T.). It is also seen from the diagram that she gave the disease to Case 28, her sister, who lived in the same house in Middleton. Cases 13 and 14 were playmates, Case 19 was the grandmother of Case 13 and lived in Rhodes ; Case 27 was the daughter of Case 19. Case 17 (N.B.) gave the disease to Case 57 (E.W.). Case 57 was called in to give an opinion as to the nature of the rash in Case 17.

At the same time that the disease was being notified in Rhodes, cases were also being notified in the main portion of the borough, especially among the children attending the Durnford Street school. On account of the incidence of cases in the Durnford Street school, the Medical Officer of Health visited the schools to make investigations, and as a result he discovered Case 13 (A.R.). This child was unvaccinated and, as previously mentioned, visited Rhodes twice weekly for attention to her hair, and she not only gave the disease to people in Rhodes, but was the chief source of the infection in the school. This has been indicated in the diagram by an arrow pointing to the centre of the school.

School Outbreak.—A short history of Case 13 is as follows :—

Onset of disease ...	16th September.
Absent from school ...	17th and 18th September.
Attended school ...	19th to 24th September.
Rash first noticed ...	24th September.
Absent from school ...	26th September to 2nd October.
Attended school ...	3rd October to 12th October.
Case discovered ...	12th October.

It is seen that the child was in school at intervals from the 16th September to 12th October, during the whole of which time she was in an infectious condition. She was in Standard IV., Room 6. The results of this missed case remaining in the school are shown by the number of cases occurring in the school, as seen in the large circle coloured yellow on the diagram.

Outbreak in the Main Area of the Borough.—It is seen from the diagram that the school outbreak was the source of the infection in the majority of the cases occurring in the borough, and shows the ultimate results of an undiscovered case of smallpox attending a large elementary school. The following details indicate how the spread of the disease occurred :—

From Case 24 to 41—Bedmates.
,, ,, 31 ,, 43—Son and mother.
,, ,, 26 ,, 64—Playmates.
,, ,, 26 ,, 71—Not playmates, but they frequently quarrelled because No. 71 interfered with No. 26 in her play with other children.
,, ,, 71 ,, 69—On making enquiries from the mother of Case 69, she mentioned the fact that she had nursed the baby at the house of Case 71, and that the children in this house were suffering from "chicken-pox." On following up this information, Cases 71, 72, 73, 74, 75, and 76, all living in the same house and members of one family, were discovered.
,, ,, 9 ,, 50—Playmates.
,, ,, 9 ,, 38, 42 & 44—Members of the same household.
,, ,, 11 ,, 47 & 48—Next door neighbours and playmates.

From Case 7 to 40—Son and father
,, 16 ,, 51 & 36—Members of the same household.
,, ,, 10 ,, 45—Playmates.
,, ,, 18 ,, 52 & 53—Members of the same household.
,, ,, 20 ,, 39—Sisters and members of the same household.
,, ,, 25 ,, 29—Son and mother. Case 29 was a doubtful case.

The Circle B in the diagram represents two people, the grandfather and uncle of Case 26, and possibly a third person who was a lodger. These three persons all lived in the same house with Case 26. They were also clubmates of Case 83. There is no evidence that the group of persons indicated by Circle B actually suffered from smallpox, but it is likely that Case 83 contracted the disease at his club, and thus it is possible that one of this group of persons suffered from the disease.

It will be seen at the right hand bottom corner of the diagram there is a group of cases not connected with the school. Case 61 may possibly have contracted the disease in the school, and the doubtful origin of the case has been indicated in the junior school by a query mark. Her last attendance at school was the 18th October, and the onset of her attack was October 31st, or possibly the 30th. This would give an incubation period of 12 or 13 days. On the other hand, Cases 61 and 62 were members of the same household. Case 62 had no connection with the school, but worked at the shop of Case 63, and Case 61 also went daily to the shop of Case 63 to take her brother's meals. Thus we have Cases 61, 62 and 63 thrown together daily at the premises of Case 63. This shop was the shopping centre for the Little Park area of Middleton, in which area Case 54 and Case C lived, both of which were missed cases. There is also evidence that the family of Case 54 shopped at the premises of Case 63; in fact, on the Saturday previous to November 1st, Case 63 gave some fish to the family of Case 54. November 1st was the date of admission to hospital of Case 54 and family. Moreover, Case 63 is stated to be very fond of children, and was in the habit of giving them sweets and fruit from his shop. Case 54 was a child 2½ years old, and Case C was a child of eight years. Thus we have Cases 61, 62 and 63 contracting the disease together; they were frequently together in a definite place, and there is evidence of an infected person or persons visiting that place.

Case D was a playmate of Cases 54 and 55, and there is evidence that she had a rash similar to that seen in Cases 54 and 55, and the mother of these two cases, who became Case 56, states that her children caught the disease from Case D. Another possibility is that Case 54, who attended the picture house with her mother on October 2nd, contracted the disease there.

Case 81 probably derived her infection from Case 55. They were in the same class at the Tonge school, and Case 81 frequently played in the neighbourhood of the house where Case 55 lived.

Middleton Junction Area.—During the greater part of the period of the epidemic, the Middleton Junction portion of the borough had been free from cases, but on the 11th November two cases were notified (Nos. 66 and 67), both living in the same house. As the Middleton Junction area is continuous with the Urban District of Chadderton, it was desirable to trace the source of infection and to use all possible means to prevent the spread of the disease into the neighbouring sanitary district. With this object in view, a house-to-house inspection in the adjacent streets was carried out. One of my medical staff, during the course of this inspection, discovered Case 82, who had developed the disease about a fortnight previously, her illness having been diagnosed as influenza. On making careful enquiries at the home of Case 82, it was discovered that she derived her infection from Case 9, who was a relative and lived in the main portion of the borough. It is seen from the diagram that Case 82 was the source of the disease in Cases 68, 70 and 80, her father, sister and mother. She also infected her aunt, who lived in Middleton (Case 77), also three inmates of the next house, Cases 66, 67, and 79. Case 82 was also responsible for the infection of a child in the main portion of the borough, Case 78.

My medical staff offered vaccination to the contacts of these cases in Middleton Junction and to all persons living in the adjacent streets, and no further spread of the disease was discovered.

The number of cases in the second part of the epidemic was 80, making with the 3 cases in the first outbreak a total of 83. The following table shows the age and sex distribution of the persons attacked during the whole epidemic :—

Table II.

Age period.	Males.	Females.	Total.
Under 5 years	1	3	4
5 and under 10 years	5	17	22
10 ,, 15 ,,	8	18	26
15 ,, 20 ,,	3	3	6
20 ,, 30 ,,	—	4	4
30 ,, 40 ,,	—	3	3
40 ,, 50 ,,	5	6	11
50 ,, 60 ,,	2	1	3
60 and upwards	2	2	4
	26	57	83

It is seen that there were 26 males and 57 females. No deaths occurred. The large number of cases occurring during the age periods ~~five to ten years and~~ ten to 15 years is accounted for by the fact that a missed case, aged ten years, attended the Durnford Street school in an infectious condition, and was mixing with children about her own age.

The majority of the cases were mild in character, but cases of varying degrees of greater severity were seen from time to time. Healthy persons were affected as readily as the unhealthy.

VACCINATION.

From information supplied by the Vaccination Officer, by estimating the number of vaccinations carried out on men during their war service, and by investigations carried out amongst school children and persons living in affected houses, it is estimated that about 35 per cent. of persons up to 40 years of age living in the borough of Middleton had been vaccinated at least once. It was not possible to form any estimate as to the state of vaccination of the population over 40 years of age.

A summary of the births registered, and the number of primary vaccinations carried out during two decennial periods is as follows :—

Period.	Births.	Primary Vaccinations.	Percentage of Vaccinations.
1900-1909	6,236	3,805	61
1910-1919	5,265	1,464	27
Total	11,501	5,269	45

The number of houses in which cases of smallpox occurred was 45, and the total number of inmates of these houses was 258 ; of these persons, 83 were attacked with smallpox, and 175 escaped the disease.

In 26 houses one case occurred.
In 8 ,, two cases ,,
In 7 ,, three ,, ,,
In 2 ,, four ,, ,,
In 2 ,, six ,, ,,

None of the 83 cases had been vaccinated or re-vaccinated within a period beginning seven years before and ending ten days before the onset of the disease.

The following tables show the vaccinal condition of the persons attacked, and also the state of vaccination of the inmates of the affected houses who escaped the disease :—

TABLE III.

Persons attacked by Smallpox.

Age period years.	Un-vaccinated.	Primarily Vaccinated after 3rd day of incubation period.	Vaccinated in infancy.	Vaccinated in infancy, and re-vaccinated after 3rd day of incubation period.
Under 5 years	3	1	—	—
5–10 years	13	9	—	—
10–15 ,,	21	4	1	—
15–20 ,,	4	1	1	—
20–30 ,,	4	—	—	—
30–40 ,,	1	1	1	—
40–50 ,,	2	1	5	3
50–60 ,,	—	—	3	—
60 years and upwards	1	—	2	1
	49	17	13	4

TABLE IV.

Inmates of affected Houses who escaped Smallpox.

Vaccinated in infancy	14
Vaccinated in infancy and re-vaccinated on contact	95
Vaccinated in infancy and re-vaccinated prior to the present outbreak of smallpox	9
Primarily vaccinated on contact	53
Primarily vaccinated after 16 days continuous contact with six concealed cases	1
Primarily vaccinated in the Army	3
	175

It is seen from Table III. that no person under ten years of age who had been vaccinated in infancy developed the disease, whereas 26 unvaccinated persons in this age period contracted the disease. Even up to 40 years of age the protection given by vaccination in infancy seemed to exert some influence. It would appear that in persons above 40 years of age infant vaccination had lost most of its protective influence. The ages of the persons vaccinated in infancy who contracted the disease were 63, 61 (two), 55, 53, 50, 49, 47 (two), 46, 45, 43, 42, 40, 33, 15 and 10 years. No case of smallpox was notified amongst males in the age periods 20 to 30 years and 30 to 40 years. These age groups included a number of ex-Service men who had been either primarily vaccinated or re-vaccinated during their war service.

A reference to Table IV. shows that the 175 persons living in the affected houses who escaped the disease had been vaccinated either before or during the epidemic.

Dr. Ash, one of the Assistant County Medical Officers made a special investigation in 16 of the 45 affected houses, containing 112 inmates :—

Of 19 persons unvaccinated there were 18 cases and 1* escape.
Of 12 persons vaccinated over 7 years ago there were 6 cases and 6 escapes.
Of 8 persons vaccinated within 7 years, no cases, 8 escapes.
Of 38 persons primarily vaccinated over 7 years ago and re-vaccinated since contact, 1 case and 37 escapes.
Of 34 persons primarily vaccinated subsequent to contact, 6 cases and 28 escapes.
One person vaccinated in infancy, and who had smallpox in a previous epidemic, escaped.

* A child aged 12 months living in a house where six cases of smallpox were concealed, including its mother. Vaccinated successfully on the 16th day after the first contact.

The number of vaccinations performed during the epidemic is shown as follows :—

	Primary.	Re-vaccinations.	Total.
Department of Medical Officer of Health	365	802	1167
Public Vaccinators	624	1019	1643
General Practitioners	—	—	†1600
			4410

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† Information supplied by General Practitioners to Medical Officer of Health, but not divided into primary and re-vaccinations.

If to this total are added the estimated number of vaccinations carried out on persons from Middleton during war service and the infant vaccinations performed by the Public Vaccinator during the last seven years, the total number of recently vaccinated persons in Middleton at the end of the smallpox epidemic was approximately 9,796, or 33·9 per cent. of the total population. It is important in organising the vaccination campaign in an outbreak of smallpox to make sure that the medical staff offer vaccination to the persons who have been in contact with a case of the disease before dealing with other persons offering themselves for vaccination. Unless this is carried out, vaccination of some of the contacts may be delayed until after the third day of the incubation period.

The Assistant County Medical Officers, in carrying out the vaccinations, adopted the following methods :—

The persons offering themselves for vaccination were questioned as to their general health, and if there was any contra-indication in this the vaccination was postponed. Vaccination was also postponed in persons showing septic skin lesions, especially on the arms, unless there was a history of contact with a case of smallpox.

In performing the actual operation, the following precautions were taken :—

> The site of vaccination was washed with a preparation of ethereal soap, and the cleansing finished off with methylated spirit. The vaccine was placed on the skin either by means of shaking the tube of lymph, or by means of a blower. The instrument used in performing the vaccination was sterilised in the flame of a spirit lamp. Where consent could be obtained, four insertions were made, care being taken that they were well separated from each other. The area of operation was allowed to dry, and a lint and strapping dressing was then applied. The whole dressing was covered by an ordinary roller bandage. It was evident in the course of a large number of vaccinations that due regard to asepsis and to the proper application of dressings was amply repaid in the saving of septic complications. Very few of the vaccinations carried out by the Assistant County Medical Officers showed any marked signs of sepsis. In a few instances a low form of infection, probably due to some form of staphyloccus, was seen, but these were practically all found amongst young mill workers who were known to have removed their own dressings. In a few instances where inflammation followed the accidental rupture of the vaccine vesicles hot fomentations were applied, and when a healthy surface was obtained, healing was quickly brought about by the use of Paraffin No. 7, Army and Navy formula. In two cases in adults, a very severe constitutional reaction to vaccinia was seen, but this was attributed to a low state of immunity, as the vaccination vesicles followed a normal course. In a small percentage of the vaccinations, outlying vesicles were distributed irregularly round the main vesicles, and had the appearance of true vaccination vesicles.
>
> It was found that given aseptic conditions in the first instance and sufficient dressings properly applied, there was no need for further attention for the next eight or ten days, and the cases left undisturbed for this period ran a normal course without complications.

General Vaccinia.—No case which could be described as general vaccinia was seen in Middleton. The majority of cases reported under this heading are serum rashes. Chaveau (France) reports six to eight cases in over half a million vaccinations, and Vogt reports five cases in 100,000 vaccinations. It is, therefore, a pathological curiosity of extreme rarity.

Concurrent Vaccinia and Variola.—The medical staff were able to study this condition in 33 cases during the outbreak. The results have been recorded on Chart C (see Appendix). From this chart it is seen that in these cases of concurrent vaccinia and variola the vaccinations were performed after the fourth day of the incubation period. It is reasonable to assume that at least some of the contacts, especially in the affected houses, were vaccinated on either the first, second, third or fourth day of their incubation period, and it is probable that the successful vaccinations prevented the further development of the disease. It is usually stated that if a vaccination is carried out within the first three days of the incubation period, the symptoms of the disease will not develop. It is also seen from the chart that on and after the fifth day of the incubation period the vaccination was successful, but did not prevent the disease developing, but if the clinical notes of the cases are studied, it will be observed that although smallpox was not prevented by the vaccination, the severity of the illness appeared to be decreased, the modification being more marked the earlier in the incubation period the vaccination was performed.

The chart also shows that some of the vaccinations performed during the period included between the first day of the onset to the second day of the rash were successful. It is probable that the quantity and quality of the smallpox virus initiating the infection influenced the question of the day up to which vaccination would be successful, and it must be borne in mind that the type of smallpox in the Middleton epidemic was a very mild one. The massiveness of the smallpox infection and the virulence of the virus will vary indirectly with the number of days after incubation on which vaccination will be successful. The cases in which vaccination failed probably had a more massive infection with the smallpox virus, or a less massive insertion with vaccine virus than those in which the vaccination was successful. The potency of the vaccine virus may also have a bearing on this question. Thus, a potent vaccine virus will probably take on a later date than a less potent one. The lymph used during this epidemic was markedly successful in its results, and appeared to be of high potency. It was noted on several occasions that men who exhibited good re-vaccination marks as the result of vaccination in the army were again successfully vaccinated during the epidemic. As bearing on this point, it has been stated that a vaccination of some years' standing which would protect an individual from developing mild smallpox would not prevent that individual from developing smallpox if he came in contact with a severe case of the disease.

inversely

Most authorities are of opinion that the area of the vaccination lesions is important in the prevention of smallpox, and this would indicate that the dose of vaccine lymph is the essential feature in the efficiency of vaccinia to prevent smallpox. In short, the course of events in concurrent vaccinia and variola may be influenced by mass action between the anti-bodies of the one disease and the virus of the other.

After the second day of the rash, no case of successful vaccination was recorded in this epidemic. It would appear that the anti-bodies produced by infection with the smallpox virus are cumulative and do not reach a maximum for some 14 days, or possibly longer. Dr. Hanna, Liverpool, estimates the maximum at the second week. It is, therefore, of practical importance that a vaccination should be performed as soon as possible in an epidemic, with the object in view of having the anti-bodies at their highest when contact occurs. It is interesting to compare the results given above with those of similar observations made in other epidemics. The findings of Dr. Hanna are as follow :—

> (1) "That vaccination performed subsequently to infection with smallpox and up to the date of onset of symptoms will take and pass through its typical course."
>
> (2) "That protection is afforded against smallpox by vaccination when performed within three days after infection, but this may not be absolute in cases vaccinated for the first time ; the course of the disease, however, will be exceedingly mild."
>
> (3) "That there is abundant evidence of the value of vaccination in mitigating the severity of the disease when performed at any time after infection up to the date of onset, and even afterwards."

In a report of a Committee of the Clinical Society of London, 1878, formed to make investigations with regard to smallpox, there appears information of 22 cases of concurrent vaccinia and variola collected by Dr. Birdwood, of the Metropolitan Asylums Board, London. He concluded that vaccination performed at any time during the incubation period will be successful. This may be true also during the first period of onset, but if carried out subsequently to the initial symptoms the vaccination will not be successful nor typical in appearance. Dr. Birdwood states that he found only one case of successful vaccination performed on the day of eruption, or after that day. Dr. Hanna is of opinion that these cases will not be successful, but says that in a confluent case of smallpox the coalescence of vesicles around the inflammatory zone will give the appearance of success. On the other hand, Dr. J. Coote Hibbert (*Lancet*, May 20th, 1905) vaccinated 20 patients after the appearance of the rash, and 11 of these were successful. Ten of these 11 cases were vaccinated on one or other of the first four days of the smallpox rash ; the remaining case was vaccinated 14 days after the rash. In seven of the 11 cases vesicles appeared, and in four papules only. In five cases the vesicles were well marked. He states "it is clear that the performance of vaccination during the attack of smallpox, even in the eruptive stage, is useless as an aid to diagnosis." Dr. F. Robinson (*Ibid*, June 10th, 1905) has recorded similar results to those of Dr. Hibbert.

The results in the Middleton epidemic occupy a midway position between those of Dr. Hanna and Dr. Hibbert, and correspond more closely with those of Dr. Birdwood. It is to be noted that the Assistant County Medical Officers only recorded a vaccination as successful where there was a definite vesicle. It must be borne in mind that the irritation of a vaccinal inoculation when performed during the incubation period may evoke a small cluster of variolous vesicles over the seat of inoculation, but in this series of cases this possibility was kept in mind. The chart shows that a successful vaccination could be obtained in the Middleton epidemic up to and including the second day of the rash, and five such cases occurred, four primary and one re-vaccination, all of which were performed on the second day of the rash. These results were confirmed by several observers, and further confirmed by the Medical Officer of the Smallpox Hospital. The vesicles obtained in these cases were atypical, quarter of an inch in diameter, and tended to dry up before becoming markedly pustular. There was no question of coalescence of smallpox vesicles at the site of insertion, as there were no smallpox lesions present in the vicinity of the vaccine insertions ; moreover, the cases were mild and not confluent. These results bear out the argument already adduced with regard to mass infection with the smallpox virus in comparison with vaccination. They also lend support to the statement of Dr. Hibbert that vaccination is no aid to diagnosis in the early days of the eruptive period. In the later stages of the rash, at any rate in the type seen in Middleton, vaccination is a useful aid to diagnosis, and a positive result to vaccination after the first week of the rash would indicate a negative diagnosis of smallpox. In several instances, persons who had recovered from the disease were vaccinated and showed an entirely negative result.

SCHOOL INFECTION AND MISSED CASES.

A study of Diagram B showing the spread of the epidemic indicates the damage done by missed cases by the outburst of cases occurring around them. In the description of the epidemic, it has been shown how Case 13, an unvaccinated child and one of the missed cases, spread the infection in a large school. As previously described, it is probable that Case 13 contracted smallpox in the Rhodes portion of the town. The history of the school attendance of the case was as follows :—

Onset	16th September.
Absent from school ...	17th and 18th September.
Present	19th—24th September.
Rash first noticed ...	24th September.
Absent	26th September to 2nd October.
Present	3rd October to 12th October.
Case discovered ...	12th October.

It is seen that she was present in the school at intervals from September 19th to October 12th in an infectious condition, and the diagram indicates the results of this attendance. The school is the largest in Middleton, and is called the Durnford Street Day school. The classes in the school are mixed, the boys and girls working together. The school consists of senior mixed, junior mixed, and infant departments. The accommodation in the departments is as follows :—

Senior Mixed, 304 ; average attendance, 1918 and 1919, 218.
Junior Mixed, 400 ; ,, ,, 188.
Infant, 298 ; ,, ,, 159.
565

The junior department occupies the ground floor, and the senior the first floor. The infant department runs at right angles to the building containing the senior and junior departments. The junior and senior scholars use common stairways ; each department has its common hall, where the scholars assemble prior to going to their separate rooms.

Case 13 was a scholar in Room 6 of the senior school, and in this room the largest number of cases occurred, viz., 11 notified cases and one probable missed case. There was an intermingling of scholars in different rooms in the senior school, the girls combining for needlework and domestic work, and the boys for drawing and handwork as follow :—

The scholars of Rooms 1 and 2 work together three times a week.
,, ,, ,, ,, 4 ,, 5 ,, ,, ,, ,, ,,
,, ,, ,, ,, 3 ,, 6 ,, ,, ,, ,, ,,

The scholars in Room 6 occupied Room 2 for certain lessons, but the two classes did not use the room at the same time, and no case was notified in Room 2. The senior girls and infants used the same playground, but only occasionally together. The junior boys, junior girls and senior boys used separate playgrounds.

In Room 1 there were 3 cases notified.
,, 3 ,, was 1 case ,,
,, 5 ,, were 4 cases ,,

In the junior school three cases occurred. One other scholar in the junior school contracted the disease, but it is not certain that she actually contracted it in the school. The infant department, although there is a common playground with the senior department, escaped infection, as also did the cookery class which was attended by scholars from other schools in the district.

The spread of the disease in the school was rapid :—

Three cases were notified on the 10th October.
Four ,, ,, 11th ,,
Four ,, ,, 13th ,,
*Four ,, ,, 14th ,,
Three ,, ,, 15th ,,
One case was ,, 18th ,,

* Including the teacher of the class in which Case 13 worked.

Vaccination History of the School Children.—The persons who contracted smallpox in the school were unvaccinated, with the exception of two, aged 53 and 10 years respectively, who were vaccinated in infancy only. Dr. Ash investigated the vaccination history of 419 scholars attending the school, and the results are shown in the following table :—

Table V.

Standard. (1)	No. of children examined. (2)	Vaccinated in infancy. (3)	Un-vaccinated. (4)	Re-vaccinated during the epidemic. (5)	Primarily vaccinated during the epidemic. (6)
xVII. ...	28	8	20	2	3
VII. ...	18	11	7	3	4
xVI. ...	2	2	0	0	0
VI.	29	12	17	1	6
xV.	16	6	10	2	3
V.	29	12	17	1	10
IV. (Room 6 Senior)	51	21	30	7	9
IV. (Junior)	14	4	10	2	2
III.	34	11	23	3	7
II.	39	14	25	4	18
I.	43	16	27	1	4
Infants' ...	116	39	77	7	29
Totals ...	419	156	263	*33	†95

* Thirty-three of the 156 shown in Column 3.
† Ninety-five of the 263 shown in Column 4.

The figure 419 represents approximately 75 per cent of the average attendance, and from these figures the state of vaccination of the school was estimated, viz., 37 per cent. of the children were estimated to have been vaccinated before the onset of the epidemic, and approximately 60 per cent. at the end.

School Closure.—The Durnford Street school and the schools in Rhodes were closed on the 18th October, and the remaining schools in the borough on the following day ; the period of closure extended to 11 weeks. Theoretically, three points should be considered in deciding whether a school should be closed on account of an outbreak of smallpox :—

1.—The risk of spread of the disease by leaving the school open.
2.—The value of the information which can be obtained at the school whilst it is still open.
3.—The state of vaccination of the scholars.

The first of these will be influenced by the third.

In a severe type of the disease, the risk of spread under certain conditions might be considerable. On the other hand, the chance of severe cases being missed would be slight, and so the information to be obtained from the school would not justify the risks run in keeping the school open ; thus, in a severe type of the disease, school closure should be carried out early, as the opportunities for close contact are very great. In a mild epidemic, as in the Middleton outbreak, the conditions are different. There was no evidence that these mild cases were infectious before the onset of the rash. The probability of a case being missed when the schools were closed and the children scattered was considerable. Theoretically, in a mild type of the disease, school closure should not be adopted, and a daily inspection of the children should be made. Any child sickening would then be detected and removed before it was infectious. Information would thus be obtained as to where cases were occurring, which would be difficult to ascertain if the children were at home. Absentees could be followed up and the cause of the absence noted. Examination of a whole school with such an object in view is an easy and rapid procedure ; two of the Medical Officers examined the whole of the scholars in the Durnford Street school in less than 1½ hours. The teachers should be instructed to report illness in any child, open-air games and lessons advised, and overcrowding and close contact avoided.

In actual practice the great drawback to keeping the schools open is the fact that a large number of the parents withdraw their children from the schools, and eventually numerous absentees will be reported, and the following up of these become a formidable task. This occurred in Middleton, and school closure was the only procedure possible. Thus, on October 15th, at the Durnford Street school in the senior department, out of 248 scholars 144 were absent ; out of 234 scholars in the junior department 136 were absent ; *i.e.*, out of 482 children there were 280 absentees. It will be realised that the following up of these children had become an almost impossible task. The absentee list on the 12th October was comparatively small, the information obtained was valuable, and cases which would otherwise have been missed were discovered as a result. It would seem, therefore, that school closure should be postponed in mild epidemics of smallpox so long as the information from the school is valuable.

In a well vaccinated school the risks of spread are slight. If it were possible to carry out re-vaccination every seven years in school medical work, school closure for smallpox would be unnecessary.

MODIFIED SMALLPOX IN UNVACCINATED PERSONS.

Under this heading, Dr. Warner, Leicester (*Practitioner*, October, 1904), gives an account of modified smallpox in unvaccinated persons, and draws attention to the fact that modified smallpox in the unvaccinated has not been sufficiently emphasised in medical literature. Prof. Osler mentions mild smallpox, and smallpox without eruption, but from reading his account one is apt to form the opinion that such cases are of extreme rarity and almost invariably occur in vaccinated persons. It would be a good plan if a differentiation were made between the terms 'mild' and 'modified,' the term modified being confined to cases modified by vaccination, and mild to unvaccinated cases. The extreme mildness of a large number of the cases in Middleton in unvaccinated persons confirms Dr. Warner's opinion.

In pre-vaccination days it was known that certain people were insusceptible to smallpox. It is probable, therefore, that mildness, even to the extent of absence of eruption (*variola sine eruptione*), may take place in the unvaccinated. Smallpox cases without eruption are, for obvious reasons, seldom reported in the literature. Dr. Kathe (*Med. Supp. Review, Foreign Press,* 1919) records four cases in which the prodromal symptoms were the same in all cases. The history of exposure to infection and the simultaneous onset of all four cases showed the disease to be smallpox. There is good evidence that at least two cases of smallpox without eruption occurred in Middleton. There was one marked example in the Middleton outbreak of insusceptibility in a baby aged one year living in a house with six concealed cases of smallpox. This insusceptibility is not uncommon, and it is probable that such children lose their immunity as age advances. Dr. Sydenham (*Obser. Med.,* iii. 3) describes such a condition as "*febris variolosa,*" which he believes to be smallpox without eruption. Smallpox, therefore, may arise in the unvaccinated in the form of acute toxic smallpox, which may be fatal in a few days, or in forms decreasingly severe, even to the extent of no rash at all. These mild cases are of great importance, as from them a severe case may arise, and they must, therefore, be looked for and isolated just as persistently as the more severe forms. Their very mildness will present difficulties which will not occur in the more severe forms, both from the points of view of discovery and diagnosis when discovered.

TYPES OF SMALLPOX.

The grades of virulence of smallpox have been classified as follow :—

1.—Eastern type	... East of long. 40°, *i.e.*, east of Moscow and only between 40° N. and 6° S., case mortality 30-60 per cent.
2.—Western strain	... Central Europe, case mortality 18 to 25 per cent.

3.—West substrain	... Germany and Great Britain, 8 to 16 per cent.
4.—Amaas (S. African type) ...	... 3 to 4 per cent.
5.—Amaas substrain (American)	... 2 per cent.
Do. (Australian)	... 0·1 per cent.

Mild smallpox has recently been occurring more commonly in Great Britain. If this mild type of smallpox continues to arise in this country, the contention that "the great majority of very slight cases, which are the cause of so much trouble, occur in vaccinated persons," will require drastic revision, as in this mild type many of the cases occurring in unvaccinated persons were extremely mild; for instance, Case 13 was able to attend school during a large part of her illness.

J. P. Grant (*South African Medical Record*, January 8th, 1910) has no doubt that Amaas is mild smallpox. The name Amaas was given to the disease by the Kaffirs realising that the pus in the pocks was thick and white like soured milk—Amaas, or possibly they called it "Imasisi," their word for measles. It would prevent much misunderstanding if the term "mild smallpox" were used instead of such terms as "Amaas" and "Alastrim."

The prodromal illnesses in the Middleton cases were remarkably constant in character, and in this epidemic could be relied upon as of useful assistance in arriving at a diagnosis. In cases, however, where the rash was well developed, the distribution of that rash was found to be the most useful sign in forming a conclusion.

The causes of mild cases of smallpox are probably to be found in :—

(1) The diminution of the virulence of the virus.

(2) Congenital resistance such as occurs in many infectious diseases. In the case of the baby of one year previously referred to, it is easy to assume that the immunity now almost absolute against smallpox will decrease as age increases, so that should smallpox be contracted, it will be more severe in proportion to the age of the child. In this connection, the most severe case of smallpox in Middleton and in which hæmorrhage occurred in the pustules was an unvaccinated man of 70 years. The case from which he contracted the disease was a very mild one. ?

(3) Smallpox modified by vaccination.

THE COTTON THEORY OF INFECTION.

In this and in other smallpox epidemics in Lancashire, the question as to whether raw cotton was the means by which the infection was introduced into the district has been considered. The evidence for the cotton theory is briefly as follows :—

(1) Smallpox has been prevalent in certain cotton-growing districts from which the Lancashire cotton mills are supplied with raw material.

(2) Missed cases of smallpox are apt to occur in the workers in the cotton fields where medical supervision is lacking.

(3) Occasional infection of the cotton by such workers is inevitable.

(4) This raw cotton is imported into Lancashire.

(5) Certain employees working with this cotton have contracted smallpox when other sources of infection could not be discovered.

(6) Simultaneous outbreaks occur in persons dealing with the same material.

(7) Persons employed in the earlier processes in the cotton mills are said to be most liable to infection. By the time the cotton reaches the weaving sheds it appears to have lost its infection. No record of a case contracted in a weaving shed could be found.

(8) Outbreaks of the disease in which cotton was suspected as the source of infection appear to have a mild character, and are limited in extent.

(9) Dr. Corbin (*Proceedings of the Royal Society of Medicine*, April 23rd, 1915) suggests that the cotton may be harmless when handled in the ordinary way, but the virus will become potent when it is conveyed to the mouth in the act of moistening the fingers with saliva in certain processes.

Dr. Wright, Assistant County Medical Officer, has collected the following information with reference to the manner in which raw cotton is dealt with in the cotton growing districts of America before it is exported to this country :—

> The cotton is picked by negroes. The labourers are migratory, and work for about four months in the year. They are paid by piece work and earn good wages, and do not lightly forgo their short, profitable harvest on account of illness. The cotton ripens first in the Southern States, and then progressively northwards. The negro labourer follows the crop as it ripens, commencing at the border of Mexico and working northwards with the harvest during the next four months. At the end of this period he has earned a considerable sum of money, and returns to the south, where he dwells in overcrowded and insanitary slums in the towns. Smallpox, scarlet fever, and measles are the chief forms of infectious disease found in these districts. The negro picks the cotton by hand and throws it into a bag carried in the other hand or slung round the neck. The contents are emptied at the plantation into larger bags, and thence into wooden carts, six or eight feet deep, the cotton being pressed down in the cart by hand. The superficial layer of cotton only in the cart is exposed to the sun, light and air. The cotton is transported in these carts several miles to the gins. The contents of the carts are tipped into the gins by gravity, assisted by native labour. The cotton lint is separated from the seed and is pressed by hand by the negroes into a box mould, the sides of the mould being removed to leave the cotton in the form of a box bale. This is usually pressed at once by machinery into the bale as it is known in Lancashire. The box bale in the process is reduced in height from 10 feet to 18 ins. under a pressure of from 700 lbs. to 1,200 lbs. per square inch. The press is usually on the same site as the gin. The bales are stored in open sheds to await purchase and shipment, and are loaded on to the ships by negro labour. Samples are cut from the side of the bale with a sharp knife by native labour. Generally speaking, cotton is exposed to sunshine and air as little as possible after being picked, as these factors are supposed to exercise a deleterious effect on the quality.

In general, the type of smallpox prevailing in the United States of America since 1898 has been very mild. The cases notified are presumably the more severe ones requiring medical attention. In 434,547 cases notified during 15 years, the total deaths amounted to 7,003, giving a case mortality of 1·6 per cent. It is interesting to observe in relation to this series of cases that as the disease continued its virulence diminished in its passage from person to person, the case mortality decreasing from 2·6 per cent. in the first year progressively to 0·6 per cent. at the end of the period under review. It is also of some interest to learn that in the general prevalence of so mild a type, small outbreaks occur from time to time in which the cases are of the classical type and display a mortality of from 20 per cent. to 30 per cent.

It has been suggested that the population of the United States has developed a natural immunity to the disease, and that the mildness of the type prevailing continuously now for 23 years was accounted for by this fact. If, however, the records are studied, one sees descriptions of severe epidemics of smallpox imported from Mexico and other countries, the mortality of which is quoted in different epidemics in different years as 28, 14, 29, 25 and 28 per cent. An epidemic in Arizona in the spring of 1917 showed a mortality of 25 per cent. A virulent epidemic in Texas in the spring of 1918 showed an average mortality of 20 per cent. ; at the outset it was 30 per cent., 6 per cent. of the cases being hæmorrhagic in character. A total of 54,570 cases reported during the first seven months of 1920 in 39 States, excluding the principal cities, shows the extent of the prevalence of the disease.

The following is a list of the outbreaks of smallpox in recent years where infected cotton is suspected to have been the source of infection :—

	Primary Cases.	Secondary Cases.
Stockport, March, 1908	1	0
Stockport, February, 1909	1	2
Heywood, January, 1910	2	5
Colne, July, 1910	1	?
Chadderton, November, 1910 ...	1	5
Bury, March, 1911	1	29
Oldham, 1913	1	7
Milnrow, May, 1914	11	0

Stockport, March, 1908—The one case was a piecer who was alleged to have used saliva in the usual manner. The particular cotton had come from Memphis, where smallpox was endemic. The case was discrete and mild ; no secondary cases occurred.

Stockport, February, 1909.—The first case was missed. It occurred in a drawing tenter operative. A severe secondary case occurred, which led to the diagnosis of the primary case. The cotton was Egyptian, and was packed chiefly in the country districts.

Heywood, 1910.—Similar evidence was obtained here, where seven cases occurred in cotton operatives. The primary cases were strippers and grinders, and the rash appeared on the same day. They were employed on the same machine. The secondary cases were contacts of these. The dust from this particular machine was cleared by hand. It is now compulsory to clean the carding engine by machinery, which carries away the bulk of the dust.

Colne, July, 1910.—The Medical Officer of Health did not believe in the cotton theory, and he used the following argument: "That having regard to the amount of cotton dealt with in Lancashire, if the raw material was infected with smallpox there would be larger and more frequent epidemics." The cotton came from Memphis in America.

Chadderton, 1910.—The one primary case occurred in a girl of 14 years, unvaccinated, and working as a little tenter. The Medical Officer of Health suggested that cotton was the source of infection, "being unable to find any other source of infection unless some infected article from our last epidemic, which, however, finished four years ago." The cotton came from Memphis. The other five cases were all connected in some way with the first case.

Bury, March, 1911.—Dr. Buckley's statement from the Annual Health Report of Bury is interesting: "In the first instance only two cases were notified, the mother (Case 1) and the daughter (Case 2). On enquiry at the house it was found that another case (3) was being treated by her medical attendant for a skin disease." This case (3) was a weaver when discovered, but had recently come from another mill where she had been employed as a can tenter, and in that capacity came in contact with raw cotton. The cotton came from the Southern States of America.

Oldham, 1913.—The first patient was a girl, a cardroom operative at a spinning mill. The raw cotton came from the Southern States. The Medical Officer of Health mentions the possibility of cotton being the source of infection.

Milnrow, May, 1914.—Dr. Macewen, of the Local Government Board, carried out investigations during this outbreak. All the persons contracting the disease were employed at the new Ladyhouse Cotton Mill, which was divided into two parts. In the first part the bales were opened out and a series of processes gone through, ending with that known as roving. In the other part the cotton was finished in a variety of ways. All the workers who contracted the disease worked in the first part of the new mill, where some 132 persons were employed, whereas only 18 persons worked in the second part of the mill. Dr. Macewen, in his report, describes nine processes through which the cotton passes in the first part of the mill, viz.:—

	No. of Cases.	No. of Employees.
1.—Mixing Room	1	2
2.—Blowing Room (dusty)	2	2
3.—Carding	1	4
4.—Can-breaking	1	2
5.—Drawing Frames	1	8
6.—Slubbing Frames	3	8
7.—Intermediate Roving Frames	—	6
8.—Roving Frames	1	8
9.—Ring Room	1	90

All the cases with one exception had been vaccinated in infancy, but not re-vaccinated. The raw cotton had come from several sources; it was chiefly Mexican, but the Mexican was used for the first time on May 14th, and the rash in the majority of cases was observed on May 30th or 31st. One case sickened on May 26th, five on the 27th, one on the 28th, and three on the 29th.

In forming an opinion on evidence of this type, it is necessary to remember the large number of persons employed in the Lancashire cotton mills. In many towns practically the whole working population is employed in this manner. The Milnrow outbreak appears to be the only instance in which the evidence strongly supports the cotton theory of infection, but even in this instance it is difficult to understand, if the cotton was so heavily infected as it must have been, why cases did not occur in other mills, and if it survived the nine processes mentioned, why some cases did not occur in the second part of the mill.

In the early stages of the Middleton outbreak it was suggested on various occasions that cotton was the original source of infection, but the medical staff engaged in dealing with the epidemic unanimously formed the opinion that personal contact, and the occurrence of missed cases, are the main factors in the conveyance and spread of this type of smallpox. The degree of infectivity of the disease was found to be low. There is no evidence that infection was carried by inanimate objects. It is easy to understand how mild cases of smallpox of the type seen in Middleton might easily escape the sanitary authorities of seaports. There is constant and rapid communication between the industrial towns of Lancashire, and also between Lancashire and other parts of the United Kingdom. Missed cases of smallpox in these mild outbreaks are probably much more numerous than is generally supposed, and such cases occurred in Middleton in unvaccinated persons. The cotton theory rests mainly on negative evidence; it is the great difficulty of tracing the missed case that makes the cotton theory at times acceptable.

It is probable that in cotton growing countries a certain amount of raw cotton is handled occasionally by persons suffering from smallpox. Until, however, more is known of the nature of the infective agent and its power of resistance, it is advisable to keep an open mind as to the cotton theory of infection. In the event of an outbreak of smallpox occurring in a cotton town, every effort should be made to trace the infection to an existing case of the disease before deciding that cotton or other inanimate objects are the carriers of infection.

As the knowledge of infectious diseases grows, the significance of the carrier and missed case assumes an increasing importance in the spread of infection. Within the last fifteen years, the medical profession as a whole has not had the opportunity of studying and gaining experience in the diagnostic features of smallpox. It is almost certain that the first cases, in mild outbreaks of this type, will become missed cases of smallpox. In fact, it is probable that the first cases in many instances would not even consult a medical man. Research work on the resistance of the virus would be helpful in finally settling the question as to whether cotton can be the source of infection in outbreaks of smallpox, but, unfortunately, the causative organism of smallpox is not known.

CLINICAL NOTES.

Dr. Ash, Assistant County Medical Officer, has supplied clinical notes with reference to 23 cases coming under his notice as follow :—

Case 31.—H.E., male, aged 12, unvaccinated, reported absent from school on the 10th of October, 1920. First seen 18th October, after much difficulty and obstruction from the mother.

Onset.—History unreliable, but neighbours stated that there had been marked malaise, backache, headache, and vomiting, probably commencing the 6th or 8th October.

Rash.—October 13th. When seen on the 18th, the condition was as follows :—Few scattered pustules on hands and feet and extensor surfaces of arms. Pustules beginning to dry up on face. A smaller number of papules on the body. Spot chart plotted.

The mother, who was unvaccinated, refused to be vaccinated, and she contracted the disease on October 22nd. The Assistant County Medical Officer did not see her until she was in hospital. She developed a more severe attack of the disease than her son.

House.—Better class well-kept villa. Ample open space back and front; modern conveniences.

Chicken-pox.—No history.

Case 40.—J.T.B., male, aged 45 years, vaccinated in infancy and on October 14th. Contracted the disease from another case in the same house. The vaccination took well in all four insertions.

Onset.—20th October. Severe headache and backache, loss of appetite, no vomiting. Felt better on 25th October.

Rash.—24th October. Scanty pustules on nose, chin, and cheeks, many burst and scabbing. One also on right eyebrow and one on right temple. One typical papule on left foot. No rash on wrists. Two papules on right upper arm, one on left, two on right thigh.

The points of interest are the severe prodromal illness with the scanty rash which was rapid in progress to such an extent that on the face it was drying up before that on the limbs had even vesiculated. This modification of the typical rash was probably due to vaccination. A spot chart was plotted.

House.—Old cottage property, reasonably fit for human habitation ; ample space back and front ; clean and well ventilated.

Chicken-pox.—No reliable information.

Case 41.—L.H., female, 18 years, unvaccinated, primary vaccination 16th October. Sleeping with a previous case up to removal of that case to hospital. The vaccination produced four good pustules.

Onset—23rd October. Became unwell with nausea, backache, temple headache, and dizziness—all severe ; no vomiting.

Rash.—Few papules on face 25th October, when backache subsided. There was one papule on front of right knee on the 26th October, with multiple papules on forehead and one on the posterior aspect of the left shoulder. In hospital this case developed much more rash. Spot chart plotted.

The case from which this case arose was a well marked one, and the contact was prolonged and close. This may account for the moderately slight effect of vaccination.

House.—Much overcrowded, fixed windows preventing efficient ventilation.

Chicken-pox.—No information.

Case 42.—R.T., male, aged 49 years, vaccinated in infancy, not revaccinated, contracted disease from a previous case in the house. There were four cases in all in this house and five cases in relatives. There appeared to be an extraordinary family susceptibility.

Onset.—Felt ill on the 21st October. Complained of the cold, shivered, aching in the limbs, loss of appetite, dizziness. No headache or backache, but there was marked lethargy. There was observed a pecular slurring of the speech which could not be accounted for. The central nervous system was normal. This slurring of the speech improved in hospital.

Rash.—24th October, on which date he felt better and noticed spots on his face in the evening. When seen on the 25th October, there were scanty shotty papules and one umbilicated vesicle on the forehead, one papule on the right hand between the fingers, legs clear. The patient was also suffering from acne, which rendered the diagnosis very difficult. When seen in hospital two days later, the rash was extensive and the face was well covered. A spot chart was plotted.

House.—One of a row of fairly modern artisan dwellings, cleanly kept, and in a sanitary condition.

Case 47.—E.H., female, aged 5 years, not vaccinated in infancy, primary vaccination on the 19th October.

Onset.—23rd October. Headache, no backache, nausea, no vomiting, earache. Felt better on the 27th October.

Rash.—26th October. Flat topped pustule ¼-inch in diameter, regular in outline commencing umbilication, areola marked, two in the right loin, one on the left forearm over the upper part of the supinator longus, three confluent between the vaccination lesions; one papule just above the pustule on the buttock. No further developments occurred in hospital.

Case 48.—J.H., male, aged 7 years, primary vaccination 19th October, brother to Case 47.

Onset.—24th October. Headache and vomiting; better on the 27th October.

Rash.—One flat topped vesicle just beginning to pustulate in the right supra clavicular region, ¼-inch in diameter. Areola marked. In this case, and also in case No. 47, the vaccination took well, and accounts for the extraordinary modification of the disease. On November 25th these two children were examined after discharge from hospital, and at the sites of the lesions there was typical staining with shiny papery scars.

House—Dirty.

Chicken-pox.—No history.

Case 49.—L.M., female, aged 8 years, unvaccinated.

Onset.—21st October. Starved, marked thirst, no aches, no vomiting. Got up on the 24th October.

Rash.—First noticed on the 25th October. The rash may have been present on the 24th, but the mother did not examine the child on this date. Multiple vesicles and pustules on exposed parts of the face, 3 on the right shoulder, 2 on the left shoulder, 3 on the abdomen, 2 on the right anterior fold of the axilla, many seen on the extensor surfaces of the legs, being very marked on the anterior surface of the right ankle, 2 on the sole of the right foot, 1 on the sole of the left foot. One in the right popliteal space, multiple spots on the buttocks, areola marked throughout. Spot chart plotted.

House.—Good class artisan dwelling, modern sanitary fittings, very clean.

Chicken-pox.—Had not suffered from the disease.

Case 50.—G.P., female, aged 9 years, primarily vaccinated on the 25th October, unsuccessful.

Onset.—Felt cold on the 17th and 18th October, ill again on the 25th and 26th, better on the 27th. Headache, nausea, starved, no backache or vomiting.

Rash.—Vesicles and pustules on the extensor surfaces of both feet and legs, backs of heels and backs of hands. One papule on left cheek, one on forehead, one on left eyelid, and one on left buttock. The patient had a sore throat, strawberry tongue, and a fading flush on body, no peeling. Circumoral pallor, marked glands in the anterior triangle of neck. (Scarlet fever combined with smallpox?) The rash was more advanced on the limbs than on the face, but the patient was certainly suffering from smallpox. This case illustrates the importance of not trusting to any one sign or symptom in coming to a diagnosis of smallpox.

House.—Large, airy, and very clean.

Chicken-pox.—No history.

Case 52.—R.J., male, aged 70 years, unvaccinated.

Onset.—Severe headache, backache, and vomiting; tongue much furred. Profuse acne. Illness commenced 25th October.

Rash.—29th October. Four small papules on the flexor surface of the left wrist and doubtful papules on face. Diagnosis difficult on account of acne and the filthy condition of the skin. On the 30th October, multiple papules on both wrists and below elbows, feet, and legs. Face profuse. Removed to hospital 30th October. In hospital this case developed into the most serious case of the epidemic. The rash became very profuse on the face and limbs, and somewhat less profuse on the body. The lesions exhibited hæmorrhages. When seen in hospital on the 5th January there was marked staining and much scarring, though the scars were small in size.

Case 53.—W.C., male, aged 5 years, primarily vaccinated 18th October. This case and Case 52 were members of the same household.

Onset.—No definite history of illness, but on daily visits to the house since the first case occurred on the 14th October, it had been noticed that the child had been less playful since the 25th or 26th.

Rash.—30th October. Multiple pustules on face, wrists, both hands and feet, one on each arm about centre of biceps, one on anterior aspect of thigh, one on abdomen, and a few on the posterior aspects of both thighs.

House.—Dirty, overcrowded, and generally neglected.

Chicken-pox.—Doubtful history, information unreliable.

Case 65.—E.B., female, aged 20 years. Unvaccinated, primary vaccination on the day of onset of the rash unsuccessful.

Onset.—1st November. On Monday, November 1st, she went to see her doctor, complaining of headache and nausea, loss of appetite, and constipation. Later developed diarrhœa, dizziness. No backache, but pain in the back of neck. Prostration. There was profuse acne, also " oil grubs " on the arms and hands.

Rash.—On November 6th she noticed a different rash developing amongst the roots of the hair and on the hands. The appearance of this rash frightened her to such an extent that on the next visit of the Assistant County Medical Officer she met him at the door, stating that she felt much better, but asked to be vaccinated, whereas previously she had persistently refused to accept vaccination. The fresh rash took the form of papules with definite areolæ on hands, multiple papules on forehead and in the scalp. One papule on the inner side of the left ankle, two on the right breast, and one on the left deltoid area.

House.—Clean and roomy.

Chicken-pox.—No information.

The chief point of interest in this case is that the diagnosis was rendered very difficult owing to the presence of profuse and chronic acne. The Assistant County Medical Officer had been following up the case since first hearing of her illness. A letter was sent to the Medical Officer of the Clayton Vale Hospital, to which the patient had been immediately removed, fully explaining the appearance of the new rash. In reply, the Medical Officer agreed with the difficulty of diagnosis, but stated that the patient developed typical lesions of smallpox.

Case 69.—H.R., female, aged 4 years, unvaccinated, primary vaccination 16th November, successful.

Onset.—13th November. Fever, headache, backache, and vomiting.

Rash.—The first spot came out in the first interosseous space of the right hand on the 16th November. On the 17th November there were multiple shotty papules on the forehead, a few on the hands and on the extensor surfaces of the arms, legs and feet, a few scattered papules on the body. There was a patch of erythema on the right cheek bone of long standing, and on this area particularly the papules were very marked. The patient also was suffering from scabies, as also were other members of the family. The rash developed considerably in hospital, and the case finally became a well marked one.

House.—Very clean and in good condition, situated in a congested area.

Case 71.—H.E., male, aged 8 years, primary vaccination 17th November, unsuccessful.

Onset.—29th October? The neighbours stated that the patient was in bed on that day with severe headache and vomiting.

Rash.—1st November. He was first seen on the 17th November, and there were multiple scabs on the face and hands, scanty on the legs, body clean.

Case 72.—A.E., female, aged 3 years, primary vaccination on the 17th November, successful.

Onset.—Mother would give no information.

Rash.—14th or 15th November, alleged to have first appeared on the 17th November, that is on the day the case was discovered. Distribution :—There was a large impetigo scab on the face with multiple papules situated around it. Multiple papules on the hands, arms, feet and legs, chiefly on the extensor aspects, scattered and scanty papules and vesicles on the upper arms. Front of body clear, about 20 papules on the back. Tongue furred towards the base.

Case 73.—A.E., female, aged 43 years, vaccinated in infancy.

Onset.—Information unreliable, no energy, headache, backache. There were extensive psoriasis and eczema.

Rash.—15th November. Multiple vesicles around the mouth, one on the root of the nose, scattered vesicles on cheeks and exposed parts of the face, a vesicle on palmar surface of proximal phalanx of left midfinger, scattered vesicles amongst the eczema on the forearms.

Case 74.—L.E., female, aged 5 years. Primary vaccination on 17th November, unsuccessful.

Onset.—Information unreliable.

Rash.—16th November. Two shotty papules on the extensor surfaces of both arms, 10 to 12 papules on the face, one vesicle on the back, and the legs clear.

Case 75.—J.E., male, aged 47 years. Vaccinated in infancy.

Onset.—Information unreliable.

Rash.—16th November. Shotty papules on face and scanty papules on extensor surfaces of hands and arms below elbows. There was profuse acne on the face. Case 76 states that her father (Case 75) was very ill during the prodromal illness and that he vomited.

Case 76.—A.E., female, aged 15 years, vaccinated in infancy (two small scars). Not revaccinated.

Onset.—Felt ill, loss of appetite, headache, and backache on the 12th or 13th November.

Rash.—First appearance on the 16th or 17th November. On the 17th there were vesicles and papules on the exposed parts of the face, hands, and legs. The lesions were small, but otherwise typical of smallpox. They were, however, scanty, and the case was the mildest of the six cases found in this family, namely, Nos. 71 to 76.

These six cases, Nos. 71 to 76, had been concealed, and the father and mother would give very little information regarding the cases. When questioned by herself, however, Case 76 gave the following particulars :—That Case 75 vomited during the prodromal illness, that Case 71 vomited when he was ill, that Case 72 vomited for two days during the onset of her illness. There was an unvaccinated child aged one year in the house, and although the child was freely mixing with the other six members of the family who were suffering from the disease, it showed no signs of illness, nor was there any rash. It was vaccinated on the 17th November, and sent to the hospital with the rest of the family, so that it could be properly looked after by its mother. The vaccination was successful, and the child did not develop the disease.

The household consisted of 10 persons. One member of the family, a boy aged 9 years, was primarily vaccinated on the 3rd November. He had visited one of the vaccination stations unknown to his parents ; the vaccination was successful, and he did not develop the disease with the rest of the family. The baby aged 1 year, as stated above, escaped the disease. This is an example of natural immunity. The infant must have received a very massive dose of infection, as it was being nursed by its mother whilst she was suffering from smallpox, and there were five other cases in the house not isolated. Another member of the family, aged 19 years, had been primarily vaccinated in infancy ; he also escaped an attack of the disease, probably due to the fact that he had some residual immunity from his primary vaccination ; he was revaccinated on the 18th November, and two out of four insertions exhibited poorly developed vesicles. A tenth member of the family, a boy aged 13 years, was primarily vaccinated in infancy, and he escaped an attack of the disease. He was revaccinated on the 17th November, but this was unsuccessful, and he showed no reaction.

Cases 71 to 76 all developed typical dome shaped discrete umbilicated lesions, and in a circumscribed area all the lesions were at the same stage of development. None of the cases exhibited a spot on the axillæ. Case 76 was the first to be discharged from hospital on the 6th December ; Case 72 was also markedly modified by her vaccination, vesiculation being confined to the tops of the papules.

House.—Overcrowded, very dirty, no back door, ventilation bad.

Chicken-pox.—No information.

Case 77.—E.B., female, 46 years, vaccination in infancy (four large marks), not revaccinated.

Onset.—13th November, headache, backache, no vomiting, felt better 18th November.

Rash.—18th November, first appearance. On the 19th November there were multiple papules on the hands and arms, chiefly on the extensor surfaces ; also on the prominent surfaces of the face, just commencing vesiculation. The lesions were small with a poor areola. The face, the nose, and chin were particularly picked out. There were two vesicles at the root of the nose, two atypical papules on the left leg, one on the right leg. One deep papule on the palmar surface of the proximal phalanx of the left middle finger.

House.—Clean, sanitary, and not overcrowded.

Chicken-pox.—States she had not had the disease to her knowledge.

Case 80.—K.N., female, aged 40. Primary vaccination in infancy. Revaccination on the 14th November, 3 marks, successful.

Onset.—15th November. Moderate headache and backache. No vomiting, felt cold.

Rash.—21st November. When examined on the 23rd, distribution was as follows : Four vesicles right arm flexor surface ; one large deep pustule right thenar eminence ; one vesicle right side of chin ; one vesicle right side of nose ; one vesicle right nasolabial fold ; one papule under the chin just becoming vesicular ; one vesicle on the left wrist.

House.—Clean and sanitary.

Chicken-pox.—No evidence.

Case 81.—A.C., female, aged 8 years. Primary vaccination 23rd November ; four marks, successful, but markedly modified.

Onset.—19th November. Headache, backache, shivering, vomiting, and thirst. Felt better on November 21st.

Rash.—A few spots noticed by Dr. Wright on the 22nd November. On the 23rd, when first seen by Dr. Ash, the rash was distributed as follows :—Three very small vesicles on face, forehead, and naso-labial fold ; 3 small vesicles on neck ; 4 right upper arm ; 4 left forearm, one of these latter had a well marked areola. In the others the areola was less marked. One vesicle left lumbar region ; 2 over left scapula ; 2 right scapula. The last four were larger than the others. Three papules over right knee, legs and feet otherwise clear.

House.—Dirty and overcrowded.

Chicken-pox.—No history.

Case 83.—C.D., male, aged 55 years. Primary vaccination in infancy, not revaccinated.

Onset.—19th November. Backache, headache, no vomiting, no aching limbs ; always had acne.

Rash.—24th November. On the 25th November there were scanty hard papules on forehead just over the line of the eyebrows. On the 26th the rash was as follows :— A few papules and multiple pustules on the face, body, and arms. The areola was marked in all the lesions. This case gave great difficulties in diagnosis, owing to the presence of well marked acne, but the similarity with Case No. 42 was so marked that it alone gave rise to suspicion of smallpox.

Another puzzling rash had occurred in a younger member of the family, a male aged 8 years, who had been vaccinated on 3rd November. The rash in this case occurred on the 17th November, 14 days after vaccination, and consisted almost entirely of papules with a fair number of vesicles scattered amongst them. There was one lesion on the forearm, suggesting a ruptured pustule. The rash was distributed in the axilla, abdomen, forearms markedly picked out, face free. There were definite urticarial lesions over left shoulder and upper part of chest. The lesions were of all sizes and shapes. The condition was probably an anaphylactic phenomenon after vaccination, *i.e.*, a variety of serum rash. The facts against diagnosis of smallpox were :—(1) the distribution of the rash was not typical of smallpox, (2) the rash was polymorphic in any given area, (3) the boy was successfully vaccinated 14 days previously, (4) there was no prodromal illness.

Dr. Walker, Assistant County Medical Officer, has supplied clinical notes with reference to 13 cases coming under his notice as follow :—

Case No. 4.—W.W., aged 17 years. Unvaccinated.

Case No. 33.—J.W., aged 7 years. On October 16th, temperature 104°, pulse 120, face flushed, prostrate, has vomited frothy green material, rambling during night, vaccinated October 16th, isolated.

October 17th.—Rather better, temperature 100°, pulse 120, very delirious during night, tongue brown furred, cervical glands enlarged, no rash.

October 18th.—Spots began to appear on forehead late in the afternoon of the 17th. On October 18th there were 12 papules on forehead, 13 on face, few on left forearm and hand, two very small papules right flexor forearm. Typical distribution of rash on legs and thighs, also on eyelids. Armpits free. All lesions size of pin heads. One or two on forehead already showing signs of vesiculation. Had convulsions before rash appeared.

Case No. 32.—R.W., aged 13½ years. Vaccinated October 15th, vomiting and pallor October 16th, frontal headache, dirty tongue, temperature 104°, isolated October 17th. On October 18th two papules on forehead, four on lower part of face, and none on trunk or legs.

Case No. 35.—J.B.W., aged 43 years. Vaccinated, October 15th. On the 19th October felt very ill, temperature raised, dirty tongue, aches all over, especially limbs and head, rigors. On the 20th still felt very ill, severe pains back and limbs, one isolated papule on chest, no rash on face. Patient had remains of acne pustules about face and neck. October 21st, papule on chest noted on the 20th had developed typically, and there were five tiny papules wth very marked areolæ and two vesicles, on each side of the neck one larger papule, under the left ear two papules, one papule over left eyebrow, two at the roots of the hair, and three over right eyebrow. Left forearm posterior aspect two papules, one in front of left wrist, one on the right upper arm, axillæ free, legs free except two tiny papules over right knee, four papules in the lumbar region, and three on the dorsal area of the trunk.

Case No. 34.—M.W., aged 41 years. On October 15th vaccinated primarily, on October 19th felt very ill, temperature raised, rigors, furred tongue, pains in the head, neck and back, severe diarrhœa, fainting attacks. October 20th, pains in head and neck very severe, bowels loose. October 21st, one typical papule only on dorsal surface of left wrist.

Case No. 37.—N.W., aged 10 years. On October 15th vaccinated primarily, headache and shivers on October 19th. On October 20th unable to get warm, severe headache, eyes heavy. October 21st one small macule over thenar eminence of right hand, symptoms subsiding. October 22nd no further development of rash. October 23rd two spots on dorsum of right hand and one on dorsal surface of left hand. October 24th, these spots had become definitely papular.

The previous five cases occurring in one family illustrate the severe prodromal illness and the interference with the development of the rash caused by vaccination, even when performed late in the incubation period. In all cases the lesions were small; there was a tendency for the rash to run rapidly through its stages, and in Cases Nos. 34 and 37 the rash had difficulty in appearing at all.

Case No. 57.—E.W., aged 61 years. October 11th, date of contact. October 26th, onset of illness. Severe pain head and neck., Gastric disturbance. Rash, October 30th. Notified as smallpox, November 1st. Rash first appeared on face and forearms. Rash plentiful on face, forehead, roots of hair, round the eyes, below lower lips, on neck and chest, fewer on legs and feet. None on wrists, lesions small and many already vesicular. Three marks of vaccination on each arm, all said to have been done in infancy.

Case No. 64.—H.B., aged 13 years. History vague. On October 30th, headache. November 1st, vomited, went to bed. Rash, November 4th. First appeared on face, then on arms, legs and trunk. Did not consult a doctor. Discovered by one of the school nurses whilst visiting the homes of children attending the Durnford Street school.

Case No. 68.—J.N., aged 43 years. Unvaccinated. November 8th, vomiting, pains in head, back and limbs, giddiness. November 13th, rash on face, forearms wrist. Scanty on trunk and legs. Typical papules with well defined areolæ, lesions small in size. At a second examination two hours later, there was an increase in the size of many of the papules.

Case No. 82.—L.N., aged 5 years (missed case), same family as Case No. 68. Primary vaccination failed on two occasions. Illness three or four weeks ago. Commenced to be ill on a Wednesday, and had a rash on the following Saturday, headache, vomiting, diarrhœa.

Case No. 70.—F.N., aged 9 years. Primary vaccination on November 11th. On the 13th November had to go to bed owing to headache, vomiting, and temperature. On the 14th November vaccination appeared to be taking.

Symptoms gradually subsided, and no rash appeared until the 16th November, when one doubtful lesion was seen under the right eye. On the 17th, this lesion developed typically, and two small papules appeared over the right eye, one on the forehead, one right forearm extensor surface, one flexor surface, and two back of wrist. On the left arm vaccination taken in four places, one tiny papule near the vaccination area, three on left lower arm, and one back of wrist, one over middle of the left tibia, one just behind right iliac spine, and two in the right lumbar region.

Case No. 79.—C.S., aged 34 years. Primary vaccination 11th November. Two other cases previously notified in this family (Nos. 66 and 67). November 17th, shivering attack, headache, pain in back.

November 18th, in bed, headache, pain in back, shivering.

November 19th, slightly better, headache, pain between shoulders, appetite poor, no rash.

November 20th, very languid, prostrate, says she " can't abide the smell of herself, just like our Nellie " (her daughter who had suffered from the disease). Greasy odour perceptible. No rash.

November 21st, improving. Four small papules have developed on back, no areolæ.

November 22nd, three small papules below the left ribs. Those observed on the 21st November have aborted.

P.McG., a cretin child who was said to have had " chicken-pox " three weeks previously and showed suspicious staining. Twice subjected to an attempt at primary vaccination, without success ; a probable missed case.

Case No. 8.—A.B., aged 8 years. Primarily vaccinated at his mother's request after returning home from the smallpox hospital. Negative result.

DIFFERENTIAL DIAGNOSIS.

The subtleties of the disease were such that in order to avoid mistakes a complete examination was carried out in every case. If this principle is adhered to, a correct diagnosis can be arrived at in all cases. The distribution of the eruption was typical of smallpox. It appeared more profusely on the extremities than on the trunk. Its first appearance was usually on the forehead near the roots of the hair, and in some instances was observed simultaneously on the extensor surfaces of the wrists or hands. The matured rash was observed most profusely on the face, the forehead, and the prominences of the nose and cheek bones, occasionally on the ear and lip, and even in mild cases one or more spots could be felt in the scalp. Lesions were also seen on the mucous membrane of the mouth and fauces. The hollows of the orbit and below the ears were avoided by the eruption. On the neck, the line of the sterno-mastoid muscle was frequently picked out and the anterior and posterior triangles of the neck were avoided. On the arms, the rash was more profuse on the forearms and hands than on the upper arms, and commonly more profuse on the extensor surfaces than the flexor. The antecubital fossa was usually avoided, and the axillæ were free from rash. On the lower limbs a similar distribution was usually seen. On the posterior surface of the trunk the rash was much more profuse in the scapular than the lumbar regions. On the front of the chest it was more profuse on the upper part than on the lower, and more profuse on the chest than on the abdomen.

With regard to the character of the individual lesions, the findings were in most cases anomalous. The lesions were superficial and small but regular in outline, and in consequence umbilication was as a rule absent, although from time to time by careful search umbilicated vesicles were found. The lesions often matured with unusual rapidity, and vesicles were seen in some cases in 24-36 hours, which aborted by dessication in the next day or two. These conditions were met with even in unvaccinated persons who contracted the disease. The infectivity of the disease was low and the striking distance short, and thus intimate contact was necessary for the spread of the infection.

A large number of the mild cases were plotted in diagrammatic form by Dr. Wood, Medical Officer to the Chadderton, Crompton and Royton Smallpox Hospital, and eight diagrams showing mild cases are reproduced in this report (Appendix D). It was found to be impracticable to chart the cases of more moderate severity, owing to the large number of spots. The members of my medical staff also plotted diagrams of a number of cases of mild chicken-pox which were presented for diagnosis during the period of the epidemic, and five of these are shown (Appendix E). If the two series of diagrams are compared, the differences in the distribution of the lesions in the two diseases show a marked contrast. It will be seen that the lesions in the chicken-pox cases are more profuse on the front of the trunk than on the extremities, and that the abdomen shows as many lesions as the chest. The lesions were generally found in the axillæ and other protected parts. If the individual lesions in the cases of chicken-pox were examined, frequent examples could be found where the vesicles or pustules exhibited an irregular or crenated margin, and in the folds of the inguinal and other regions the lesions were often oval in outline.

Chicken-Pox.—Every case notified during the period of the epidemic was examined by members of the medical staff. The cases presented no special difficulty in diagnosis from the fact that such features as the distribution of the rash and the history of onset showed a marked contrast to the cases of smallpox. Two cases of chicken-pox of a severe nature were seen, one in an adult and one in a child, but they showed characteristic differences from the cases of smallpox, and the true nature of the disease was proved by a positive reaction to vaccination in each case.

Acne.—It was the unanimous opinion of the medical staff that this condition caused the most difficulty in differential diagnosis. Acne is a chronic condition, and as such would at first sight appear to give rise to no difficulties. It is, however, frequently combined with intercurrent acute conditions such as catarrh, influenzal conditions, and rheumatism. The patient calls in the doctor, who finds on examination a rash, chiefly on the face, especially on the exposed parts, combined with some or all of the following symptoms :—headache, backache, nausea, fever and possibly vomiting. Even if typical acne pustules are seen, it is common to find newly forming acne lesions which are often very shotty to the touch. In addition, a very large number of the cotton workers in Middleton exhibited on the arms and legs, which are uncovered while at work, an extensive crop of papules due to a folliculitis known locally as " oil grubs." In several cases, smallpox papules, acne papules, and oil grubs were seen side by side on the same patient. When confronted with such cases, great care had to be exercised in the examination of the patients, and the evidence carefully considered. The possibility of acne and smallpox existing in the same patient had always to be kept in mind. In order to prevent the spread of the disease, it is important to make a diagnosis without waiting for the signs of vesiculation and pustulation.

Various Skin Conditions.—A large variety of skin cases were presented for examination on the suspicion that they might be smallpox : scabies, impetigo, lichen urticatus, erythema papulosa, psoriasis, bullous conditions, septic infections, and urticaria were the conditions seen. The papular forms of urticaria gave rise to some difficulty. Dr. Ash gives particulars of seven cases coming under his notice for differential diagnosis. Four of these had recently been vaccinated, the first developed a rash on the 14th day after vaccination, the second on the 15th day, the third on the 10th day, and the fourth on the 14th day. These were possibly serum rashes. Dr. Jagger mentions an instance where three out of five children in one family developed urticaria with constitutional symptoms on the fifth day after vaccination.

The following are extracts from the reports of the Assistant County Medical Officers as to their experiences during the epidemic :—

> *Dr. Wright.*—"The sparse, superficial eruption of these mild cases emphasised the importance of paying sufficient regard to the distribution of the eruption and ignoring the detailed characteristics of the individual lesions. Even the mildest cases illustrated the classical points in the distribution of the rash, which appeared more profusely on the extremities than on the trunk."
>
> *Dr. Hall.*—"The outbreak appears to have been similar in many respects to the Western type of variola. Missed cases are almost inevitable, especially in a community subject to acne (oil spots), which are likely to confuse at least the lay mind."
>
> *Dr. Walker.*—"The mildness of the attack, especially in regard to the eruption, was a disturbing factor from the point of view of diagnosis. As an epidemiological factor, the mildness of the eruption constituted a serious danger, several patients being discovered during the eruptive stage exposing themselves amongst their families, workmates, and even the public. The scantiness of the rash, at any rate up to the time of removal to hospital, was repeatedly seen, even in unvaccinated children and in adults. Occasional cases amongst adults unprotected by vaccination were of a more severe type with more extensive rash. The prodromal illness, in the cases under my observation, was typical and constant, and certainly inspired more respect than the extent and severity of the rash. The individual lesions were in every case much smaller than is usual in this disease."
>
> *Dr. Jagger.*—"There were many cases of acne, which simulated the rash in this mild type of smallpox, and difficulties in diagnosis arose in these cases which, in addition, developed influenzal symptoms which were not unlike the prodromal illness of smallpox."
>
> *Dr. Scholefield.*—"As regards the nature of the disease, it was smallpox, as shown by its period of incubation, distribution, and its powers of becoming virulent (as in Case 52). A noteworthy feature was its mildness, even in the unvaccinated."
>
> *Dr. Ash.*—"The actual diagnosis was frequently difficult in the early stages of the rash, in spite of the fact that there was an epidemic raging and that the variety of the disease was well known. There was no one characteristic sign or symptom to be relied upon, but the whole of the signs and symptoms had to be considered together in many cases before a definite diagnosis could be made."
>
> *Dr. Tomb.*—"The majority of the cases coming under my notice were mild in character, both in vaccinated and unvaccinated persons, but cases of greater severity were seen. In this type of the disease the danger of missed and unrecognised cases is considerable.
>
> "In carrying out vaccinations, one interesting point I noticed was that after the initial redness had subsided in say 12-14 days and the malaise had disappeared, I sometimes found a secondary erythema and slight swelling appeared for a day or two in the region of the elbow joint and forearm. This disappeared without causing any inconvenience. In all cases I vaccinated the upper-arm, below the deltoid insertion."

Dr. Wood, Medical Officer to the Chadderton, Crompton and Royton Smallpox Hospital, has kindly supplied the following description of the cases treated at the Racefield hospital :—

"On the 14th October 12 cases of smallpox were admitted, and by the 1st November the number had increased to 47. Afterwards, five more cases were admitted, making a total of 52.

"The ages of the patients were :—

Years ...	2	5	6	7	8	9	10	11	12	13	17	18	25	33
Cases ...	1	4	1	5	3	2	5	8	3	2	1	1	2	1

Years ...	41	43	45	46	48	49	50	53	55	62	63	66
Cases ...	2	1	1	1	1	1	1	1	1	1	1	1

"Thirty-four of the patients were under 14 years of age.

"*Condition as to Vaccination.*—Of the 52 cases, nine only showed marks of having been previously successfully vaccinated before being exposed to infection, all having been done in infancy, their ages being as follows :—

Years.		
11	... Four marks	... Area, half square inch.
33	... Three marks	... Area, over half square inch.
36	... Two marks	... Area, half square inch.
45	... Three marks	... Area, over half square inch.
46	... Two marks	... Area, three-quarters square inch.
50	... One mark	... Area, half square inch.
53	... Two marks	... Area, half square inch.
55	... One mark	... Area, quarter square inch.
62	... Six marks	... Area, one square inch.

"The vaccinated child of 11 years of age had a mild, discrete attack.

"Fifteen vaccinations had been performed during the incubation period, thirteen of these being successful. Four others and one doubtful case were vaccinated after the rash appeared, with the results as below :—

A.P.	Fourth day of rash	Unsuccessful.
A.H.	Second day of rash	Successful.
A.C.	First day of rash	Successful.
E.H.	Fifth day of rash	Unsuccessful.

"The doubtful case was vaccinated on the third day of the rash, third day in hospital (four abortive papules), and was successful.

"The last case was admitted on November 26th.

"It was difficult to apprise what, if any, modification in attack was brought about by successful vaccination during the incubation period, owing to some of the unvaccinated cases being so mild.

"All the cases were discrete, but differed markedly in severity, some having few spots, others from about 60 to 100, whilst others had many hundreds. The rash came out more profusely after admission in the cases admitted in the early stage of the eruption, spots coming out for about three days. From the history obtained from the patients or their relatives, it was found that all, except two, owned to having had a well-marked onset, and that the eruption was delayed in a few cases up to the fifth or sixth day of the illness. On examining the cases, the first thing that struck one was the extraordinary mildness of some of the cases.

"The distribution of the rash was closely studied, and was spotted on a chart in a considerable number of cases. These charts showed very vividly how the front of the trunk, especially the abdomen, escaped the rash, when compared to the face, arms, back, hands, legs and feet. The axillæ, groins, popliteal spaces, and loins were almost free in every case. The spots in all cases were round, and there were none with crenated edges. The new papules, even when very small, were distinctly indurated. Vesiculation and pustulation varied in cases, and in the same case in different parts of the body. In one case with a fairly profuse rash, most of the spots did not form good vesicles, and only one suppurated. In many of the cases, the vesicular and pustular stages were short, and the formation of crusts came on early. Secondary fever was almost absent, being well marked in two cases only. After separation of the crusts, only a few of the patients were pitted, and these marks were small and shallow ; others had elevated spots left instead of scars. These elevated parts had almost become quite level before leaving hospital.

"It was interesting to see the difference in the severity of the attack in members of the same family. The type of the disease was of low virulence, and all the cases recovered. The shortest residence in hospital was 13 days, and the longest 72 days. Complications and sequelæ were few, eczema occurred in two cases, boils in four cases, conjunctivitis two cases, and two developed dropsy of the legs."

An outbreak of smallpox of this mild type in a district where there are a large number of unvaccinated persons, especially children, and where those who have been vaccinated are already losing their immunity, can only be viewed with great anxiety. In a severe type of the disease, the source of infection is generally fairly easy to trace, and the first cases are usually discovered early. Mild outbreaks of smallpox of the type seen in Middleton require a large staff to deal with them, as the work involved in the discovery of missed and unrecognised cases, the supervision of the large number of contacts, and the increased difficulty in persuading persons to accept vaccination when the disease is of a mild type, all place a heavy strain and responsibility on the staff dealing with the epidemic.

I wish to thank Drs. Reece, Hutchinson and Arnold, of the Ministry of Health, for valuable help during the epidemic ; Dr. Niven, the Medical Officer of Health of Manchester, for arranging for the isolation of some of the cases in the Manchester City Smallpox Hospital ; and Dr. Fisher for much help during the epidemic and in the preparation of this report.

CONCLUSIONS.

1.—That the epidemic at Middleton was one of smallpox of a mild type.

2.—That the most likely origin of the epidemic was a " missed case."

3.—That missed and unrecognised cases played the most important part in the spread of the disease.

4.—That in outbreaks of this mild type of smallpox there is great risk that the first cases will be unrecognised, and the disease will have gained some headway before it is discovered.

5.—That there is no evidence the disease was spread otherwise than by personal contact. It was necessary that this contact should be fairly close before a spread of the disease took place.

6.—That no sanitary circumstances had any effect on the spread of the disease.

7.—That vaccination exercised a marked preventive influence, and vaccination performed within seven years was an absolute preventive of the disease.

8.—In infected households the disease spread with almost absolute certainty to the unvaccinated persons, the only exception being a child aged one year living with six cases of concealed smallpox.

9.—That in this type of smallpox very mild cases frequently occurred in unvaccinated persons.

10.—That in this mild type of smallpox vaccination can be successfully performed up to and including the second day of the rash in some of the cases. A successful vaccination in the case of a rash of seven days' standing would negative a diagnosis of smallpox.

11.—The prodromal illness in the majority of cases was well marked and often severe, and bore no direct relationship to the amount of the rash which subsequently developed. A number of the missed cases felt quite well after the development of the rash, and mixed with the general public.

12.—That in this epidemic the infectivity during the prodromal illness was very slight or absent.

13.—That in outbreaks of mild smallpox school closure should be delayed so long as the information obtained from the school is useful. Missed cases occurring in absentees were discovered by this means.

14.—Drastic measures should be adopted in instances where there is evidence of deliberate concealment of smallpox patients, or wilful exposure of an infected person.

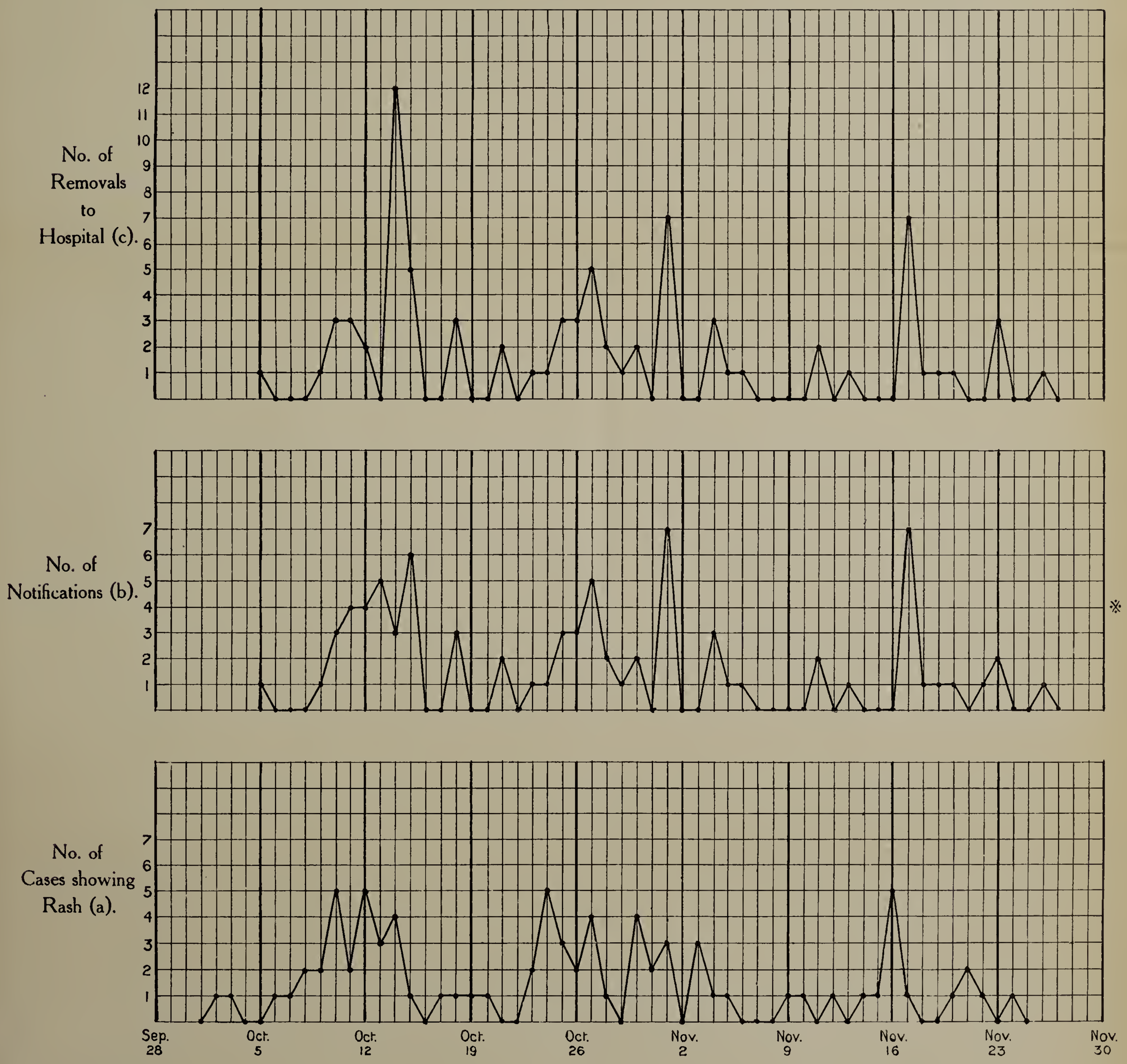
15.—That the suppression of the epidemic was due to vaccination, re-vaccination, supervision of contacts, and the discovery of missed cases.

J. J. BUTTERWORTH,
County Medical Officer of Health.

Public Health Department,
County Offices, Preston,
December, 1921.

Chart A.

Daily Record of Number of Cases showing (a) first signs of rash, (b) notifications, and (c) removals to hospital.



NOTE.—The abscissae indicate Days, and the ordinates Cases. ※Four cases notified in Oldham (C.B.) week ended December 7th.

CONCURRENT VACCINIA AND VARIOLA.

Nº of Case	DAY OF VACCINATION																		
	Incubation Period												Onset			Rash			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	1	2	3	4
51					R														
41						P													
53						P													
48								P											
79								P											
37									P										
40									R										
47									P										
34										P									
44										P									
35											R								
32												P							
36												P							
70												P							
80												P							
50													P						
33														P					
38														P					
65																P			
74																P			
29																	※R		
45																	P		
67																	P		
69																	P		
72																	P		
81																	P		
46																		P	
66																		P	
30																			P
71																(17 days after Rash)			P
82																(18 days after Rash)			P
3																after Discharge from Hospital			P
8																			P

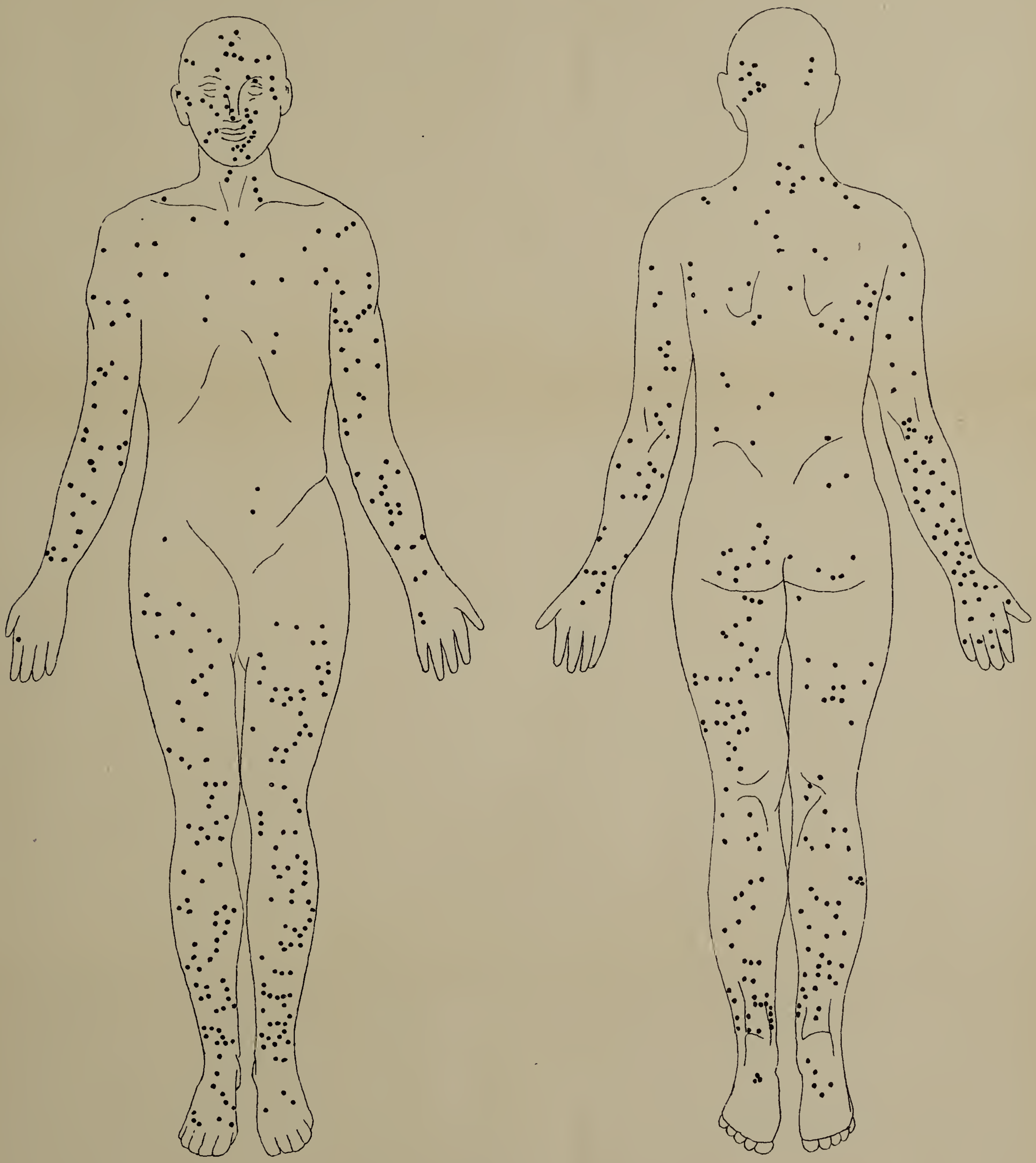
(after Hanna)

P—Primary Vaccination. R—Re-vaccination. RED—Vaccination Successful. BLACK—Vaccination Unsuccessful.
※ Doubtful Case.

Diagram D 1.

SMALL-POX, Case No. 25.

J.W., aged 9 years, unvaccinated. Mild discrete attack.



SMALL-POX, Case No. 49.

L.M., aged 8 years, unvaccinated.   Mild discrete attack.

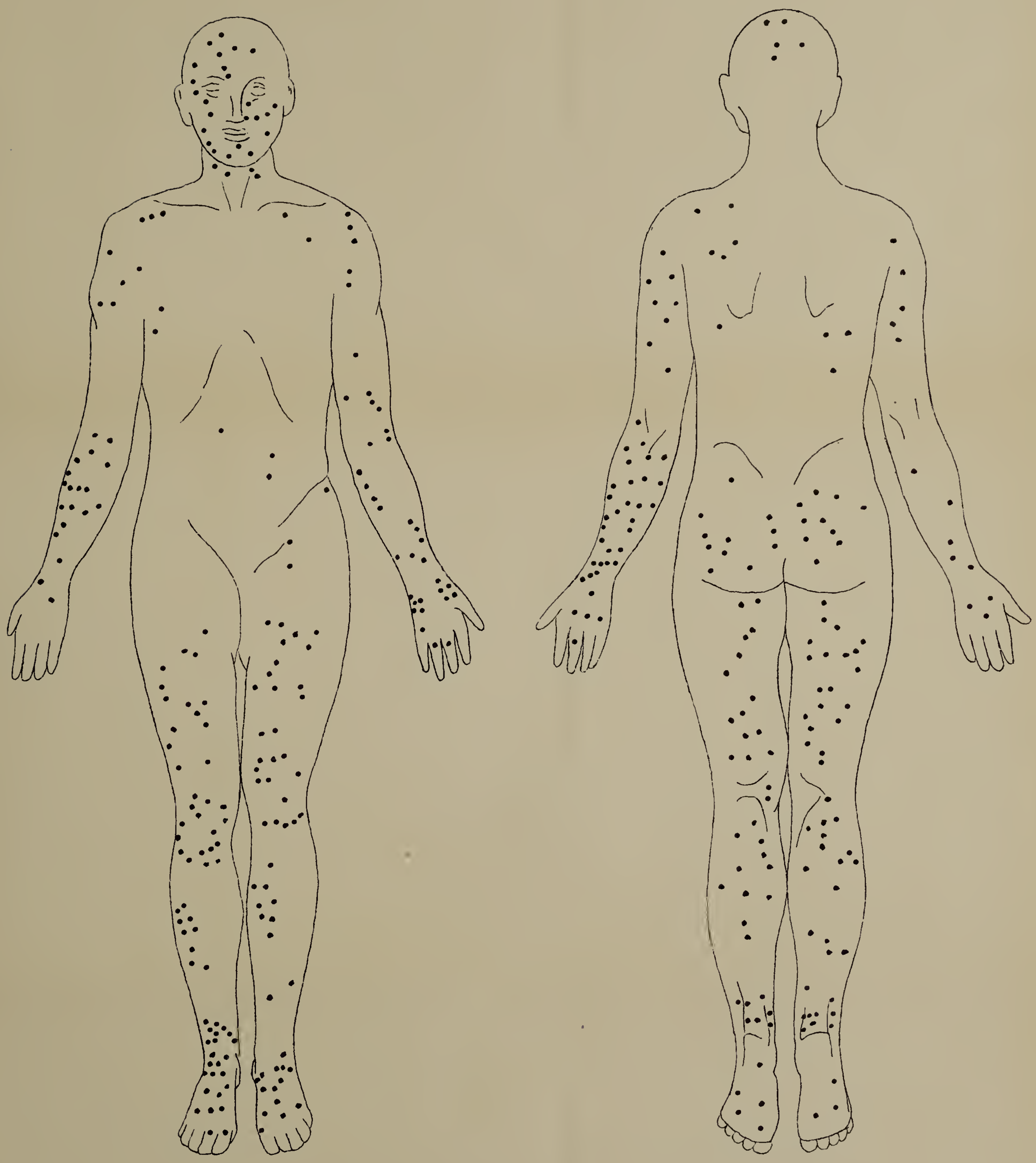
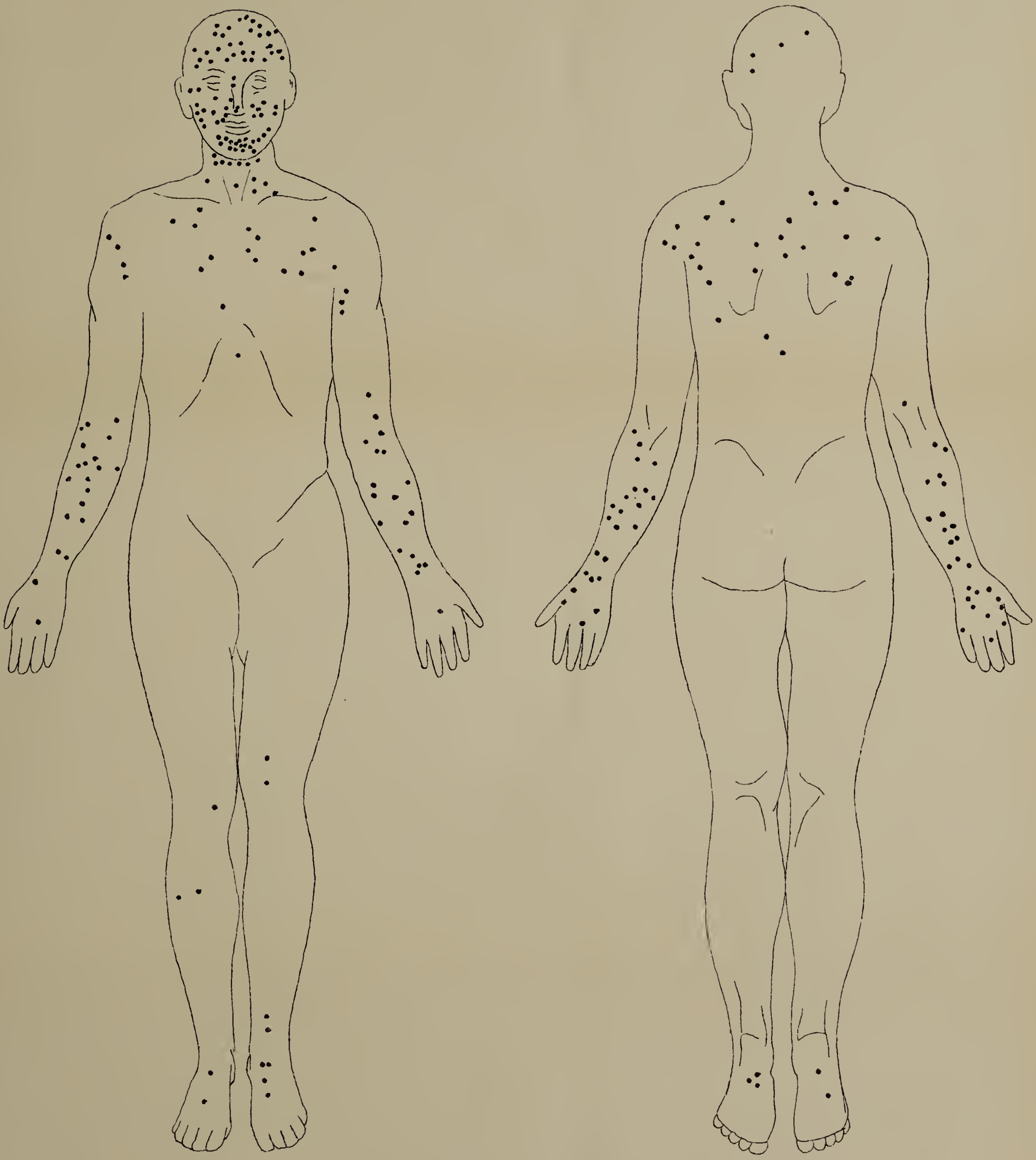


Diagram D 3.

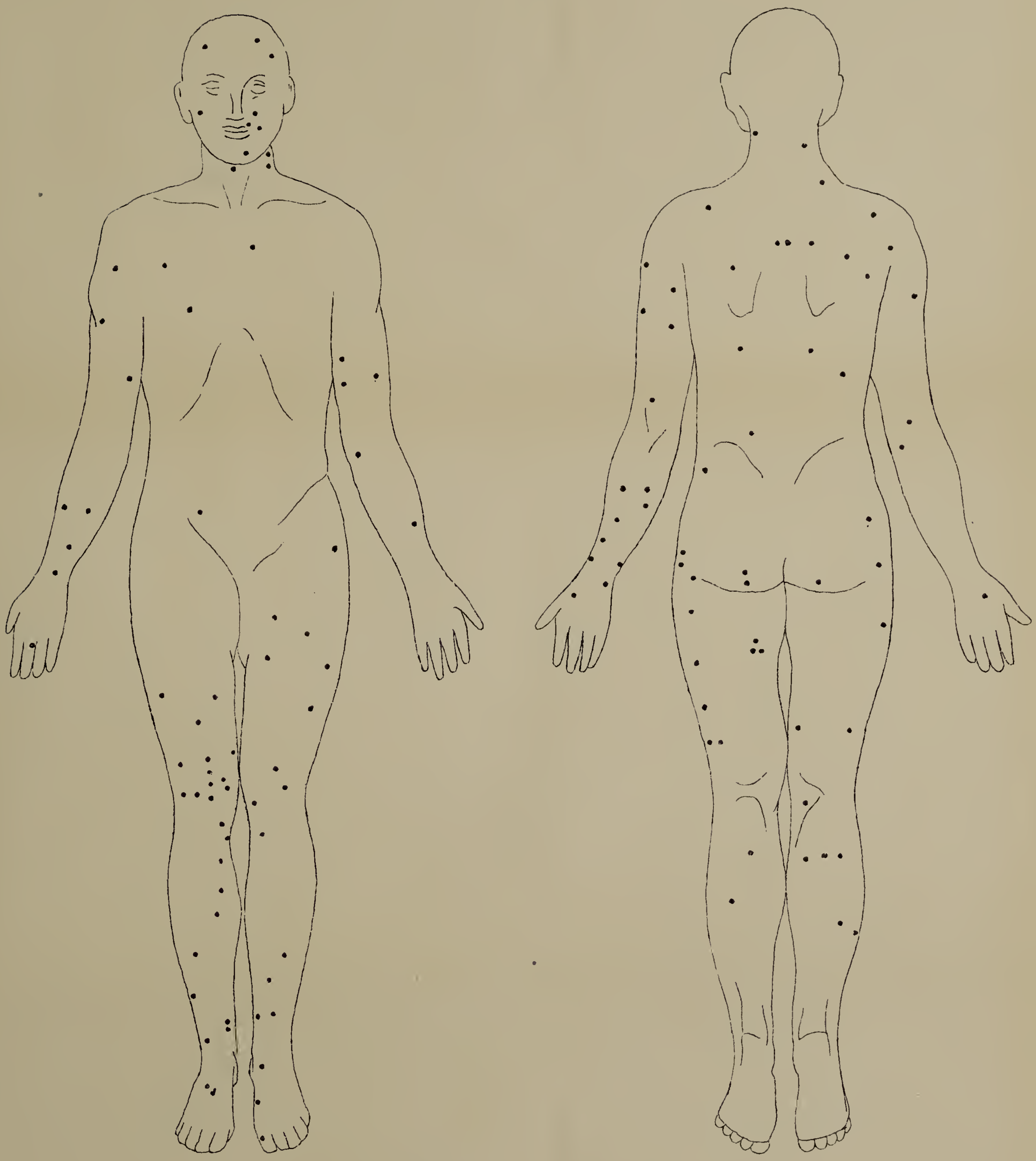
SMALL-POX, Case No. 43.

Female aged 41 years, unvaccinated.   Discrete attack.



SMALL-POX, Case No. 81.

A.C., aged 8 years, developed rash November 22nd, vaccinated successfully on November 23rd. Mild attack.



SMALL-POX, Case No. 31.

H.E., aged 12 years, unvaccinated. Mild discrete attack.

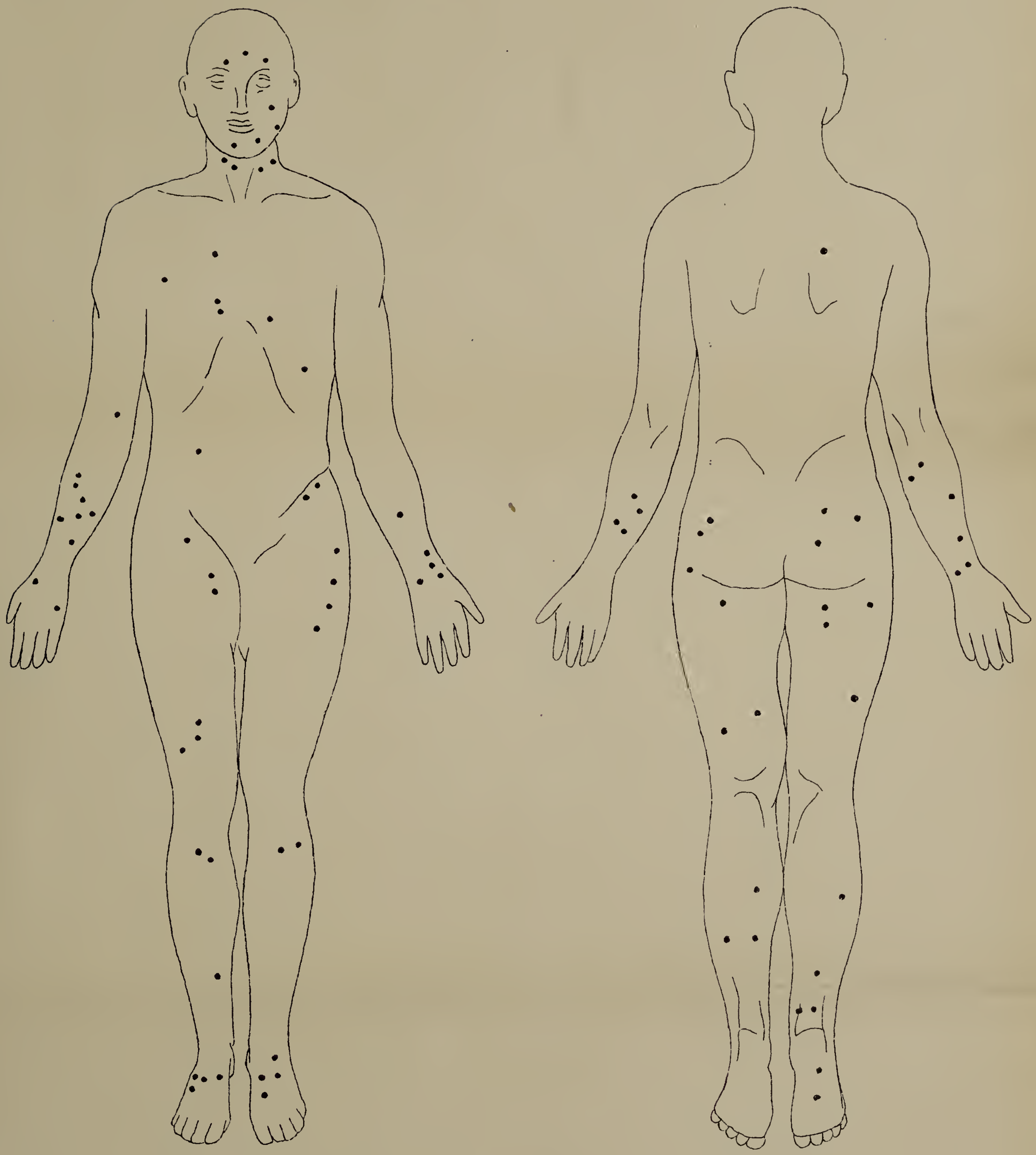


Diagram D 6.

SMALL-POX, Case No. 46.

A.C., aged 9 years. Rash developed October 24th, primarily vaccinated October 28th, with a negative result. Mild discrete attack.

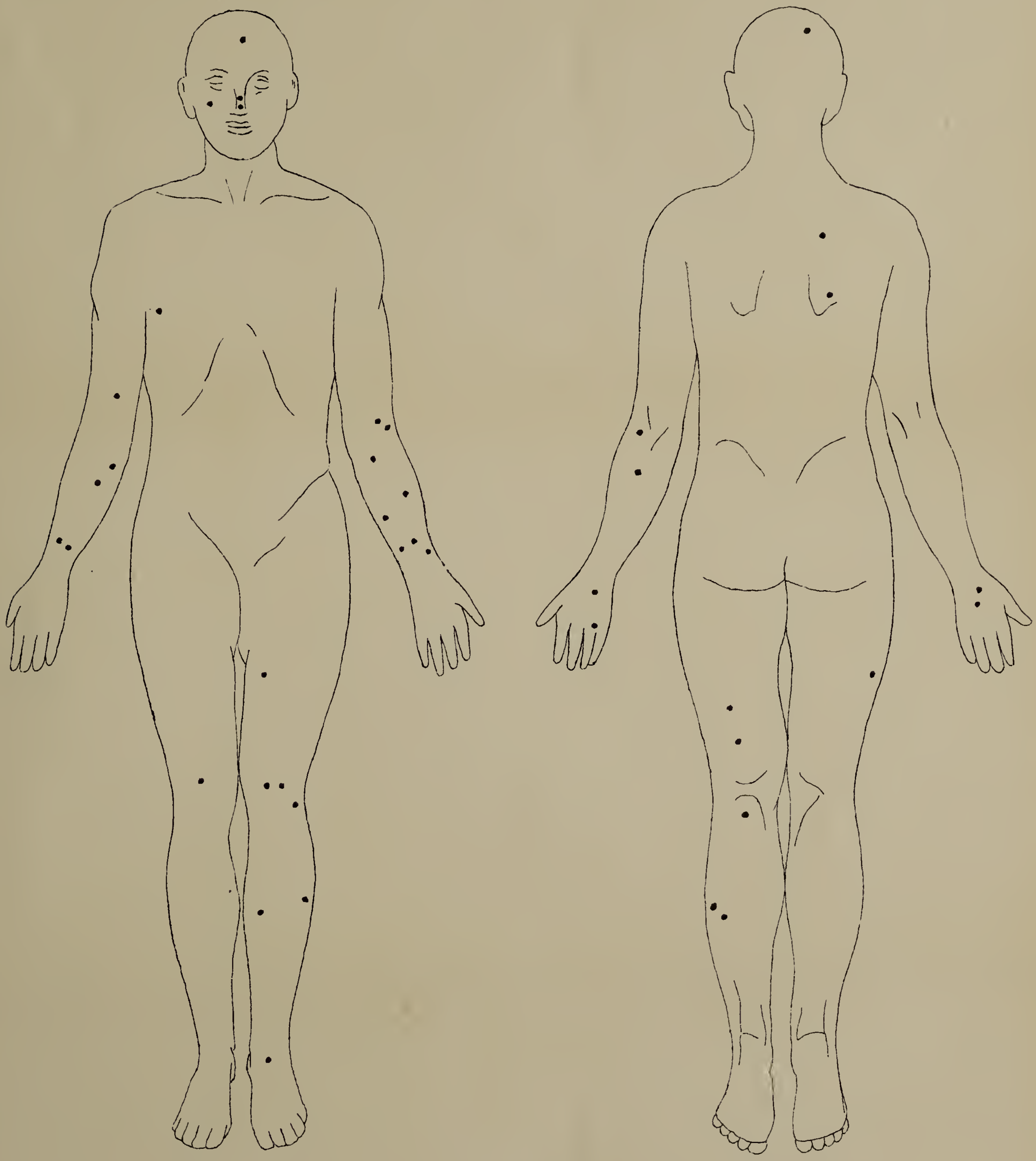


Diagram D 7.

SMALL-POX, Case No. 58.

T.S., aged 10 years, unvaccinated. Mild discrete attack.

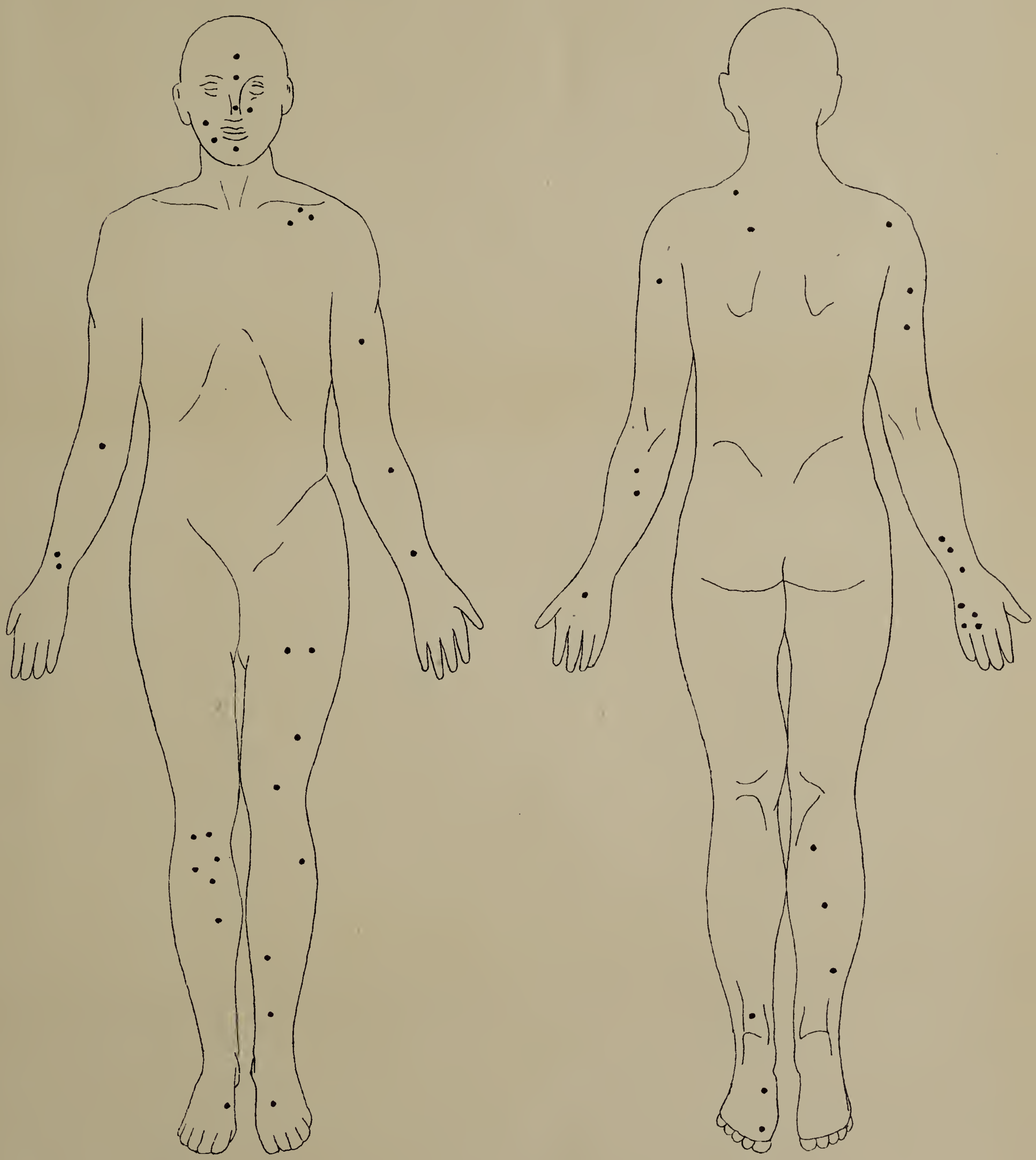
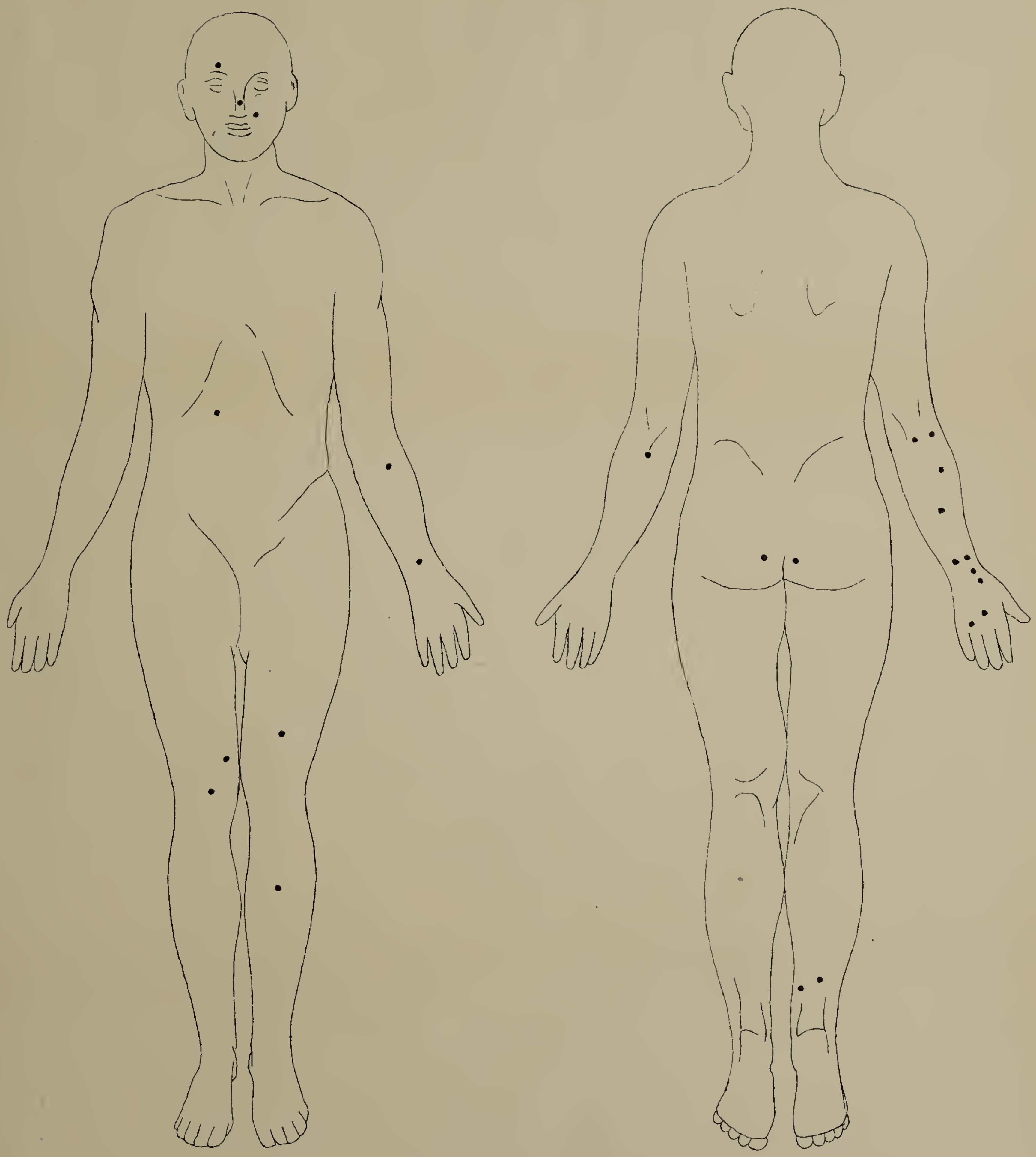


Diagram D 8.

SMALL-POX, Case No. 78.

E.S., aged 11 years, unvaccinated. Mild discrete attack.



CASE OF CHICKEN-POX.

G.L., aged 4 years.

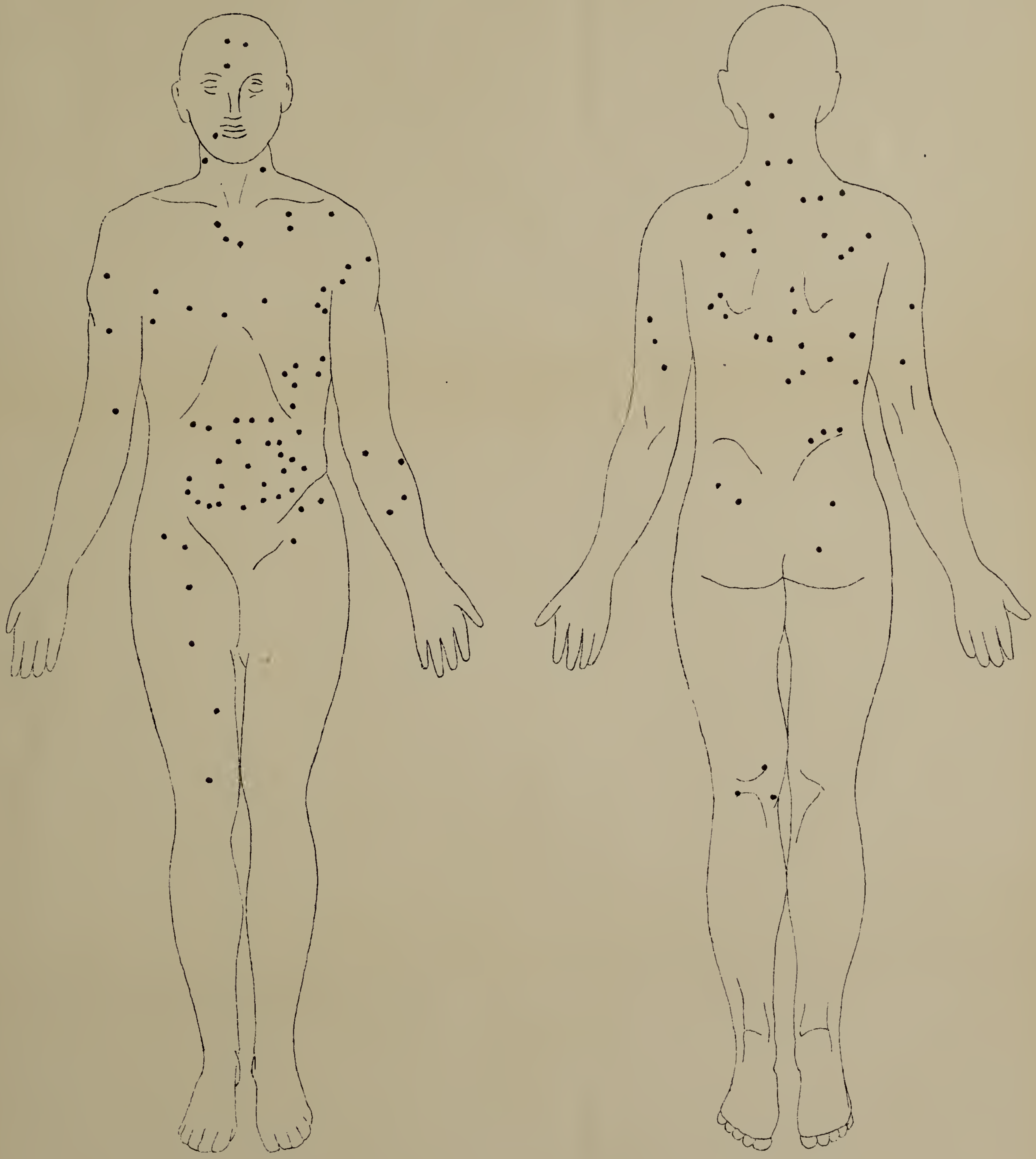
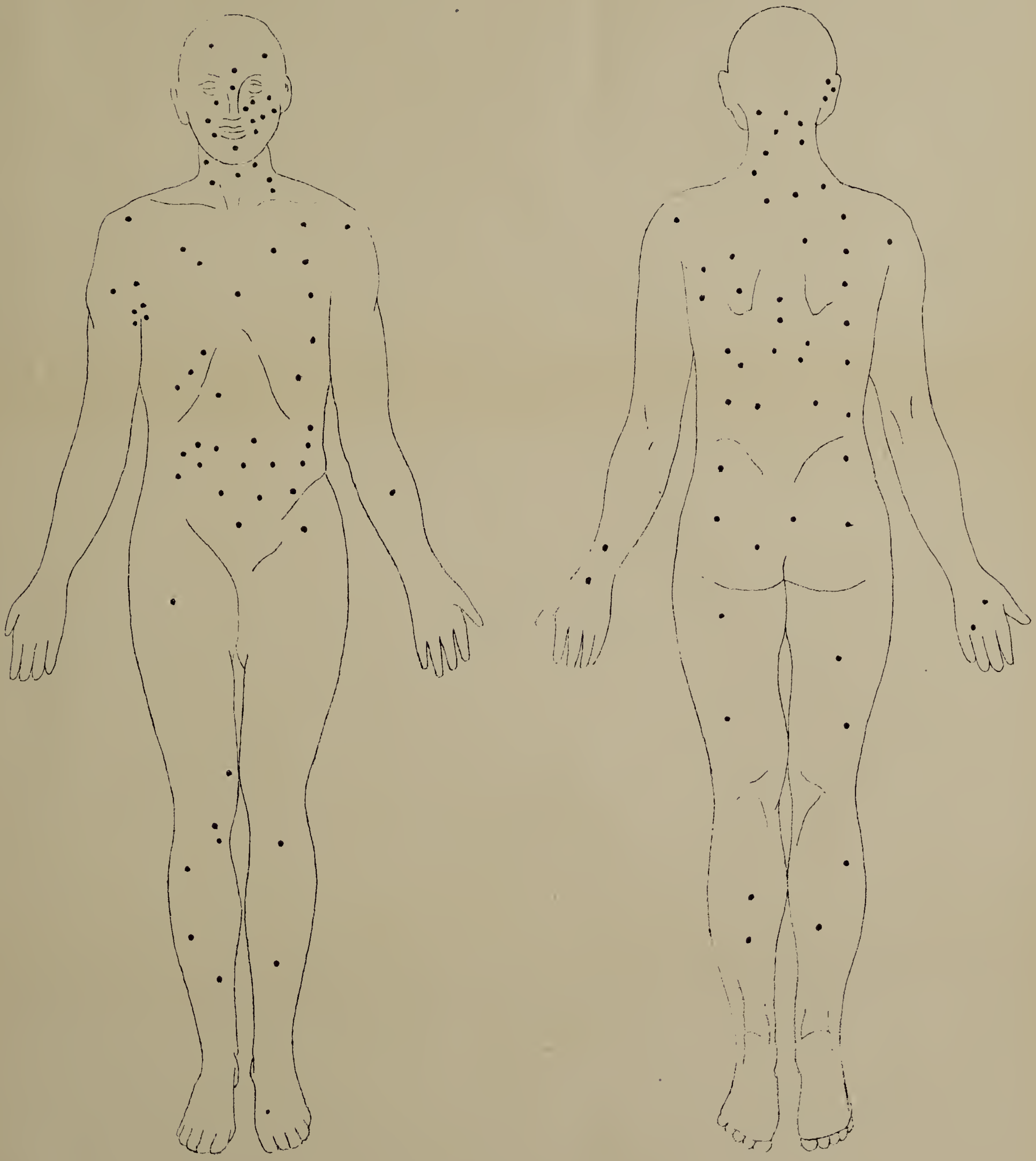


Diagram E 2.

CASE OF CHICKEN-POX.

E.K., aged 3 years, primarily vaccinated one month before onset.



CASE OF CHICKEN-POX.

A.W., aged 6 years.

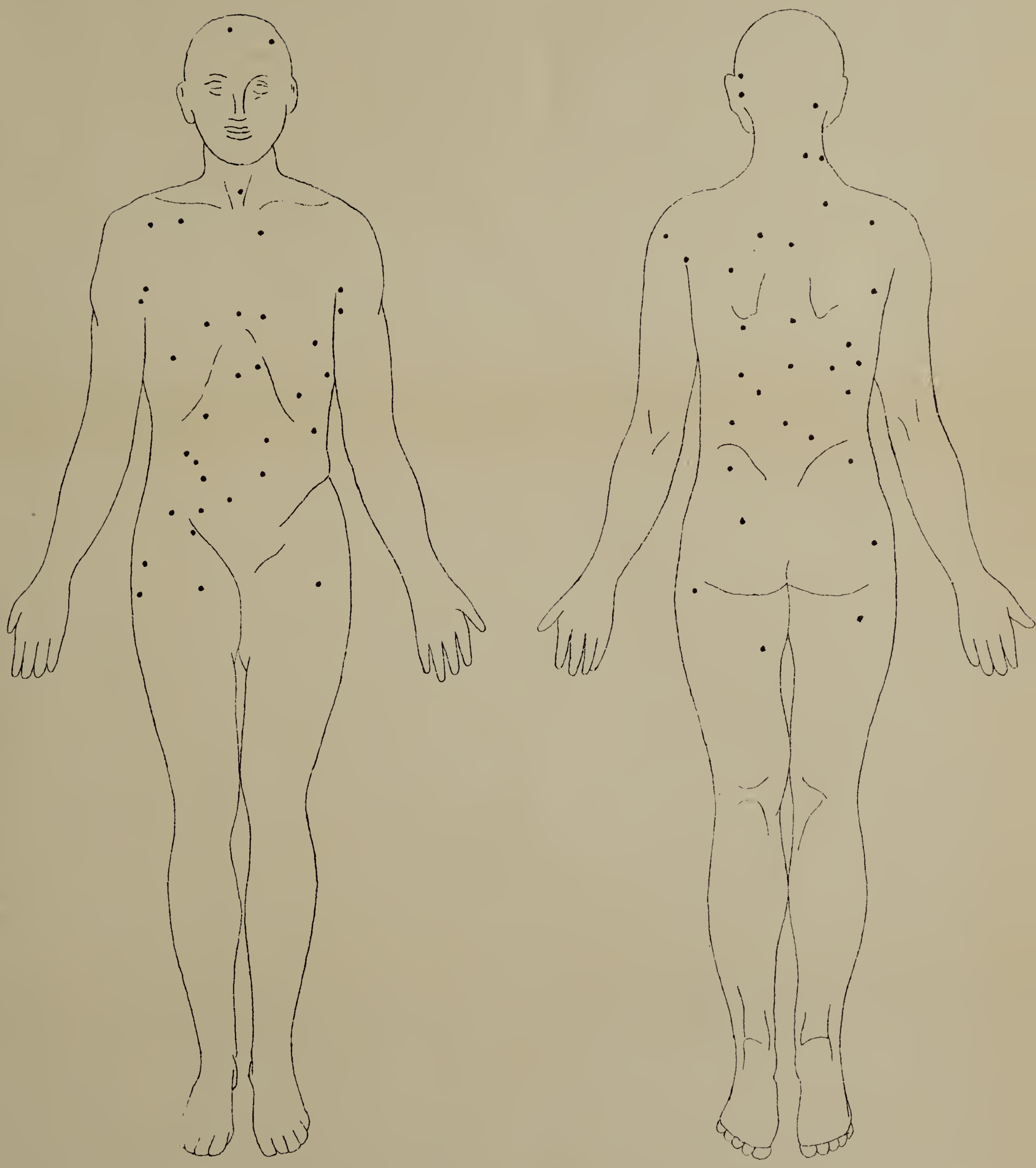


Diagram 24.

CASE OF CHICKEN-POX.

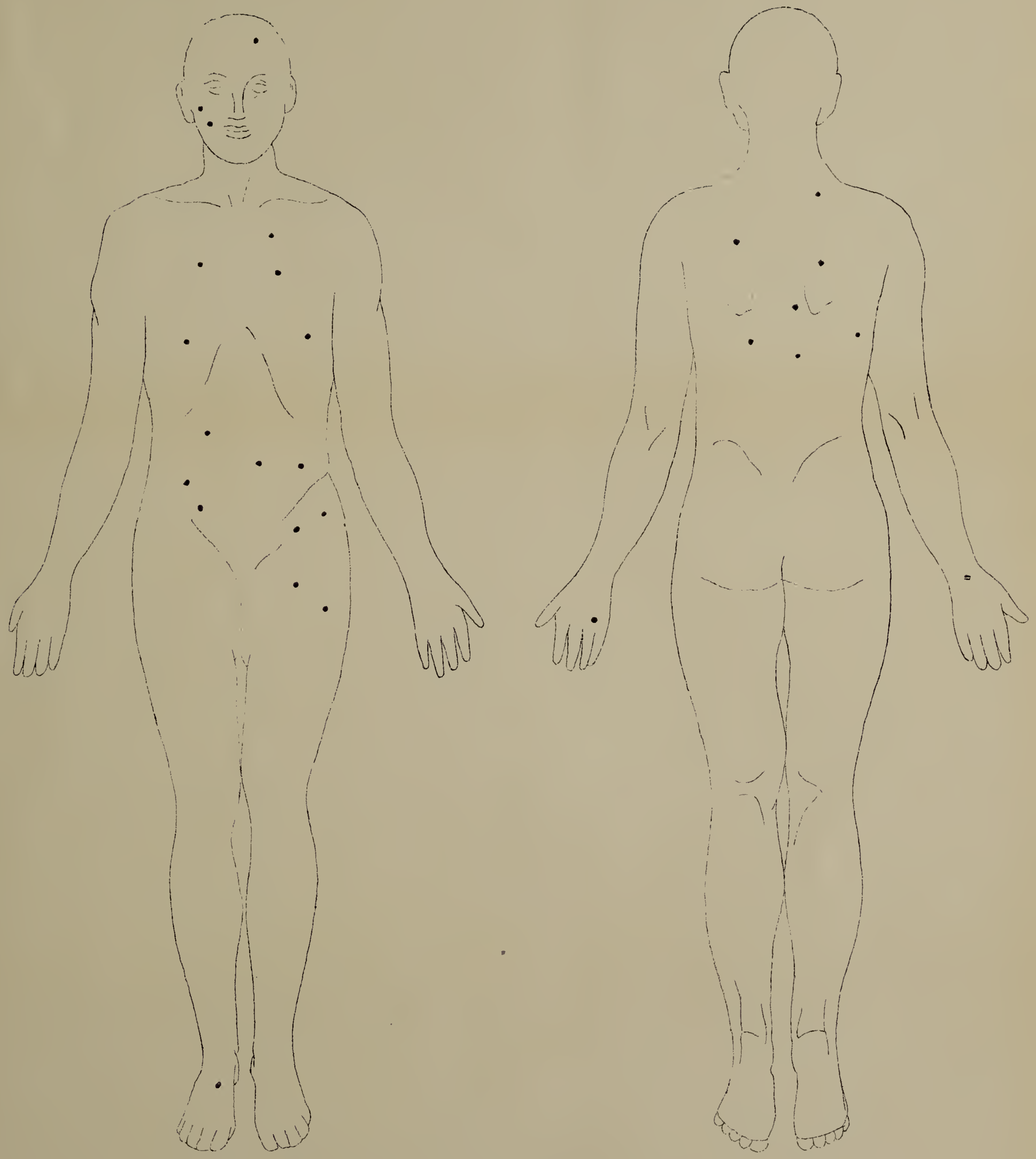


Diagram E5.

CASE OF CHICKEN-POX.

G.A., aged 2 years.

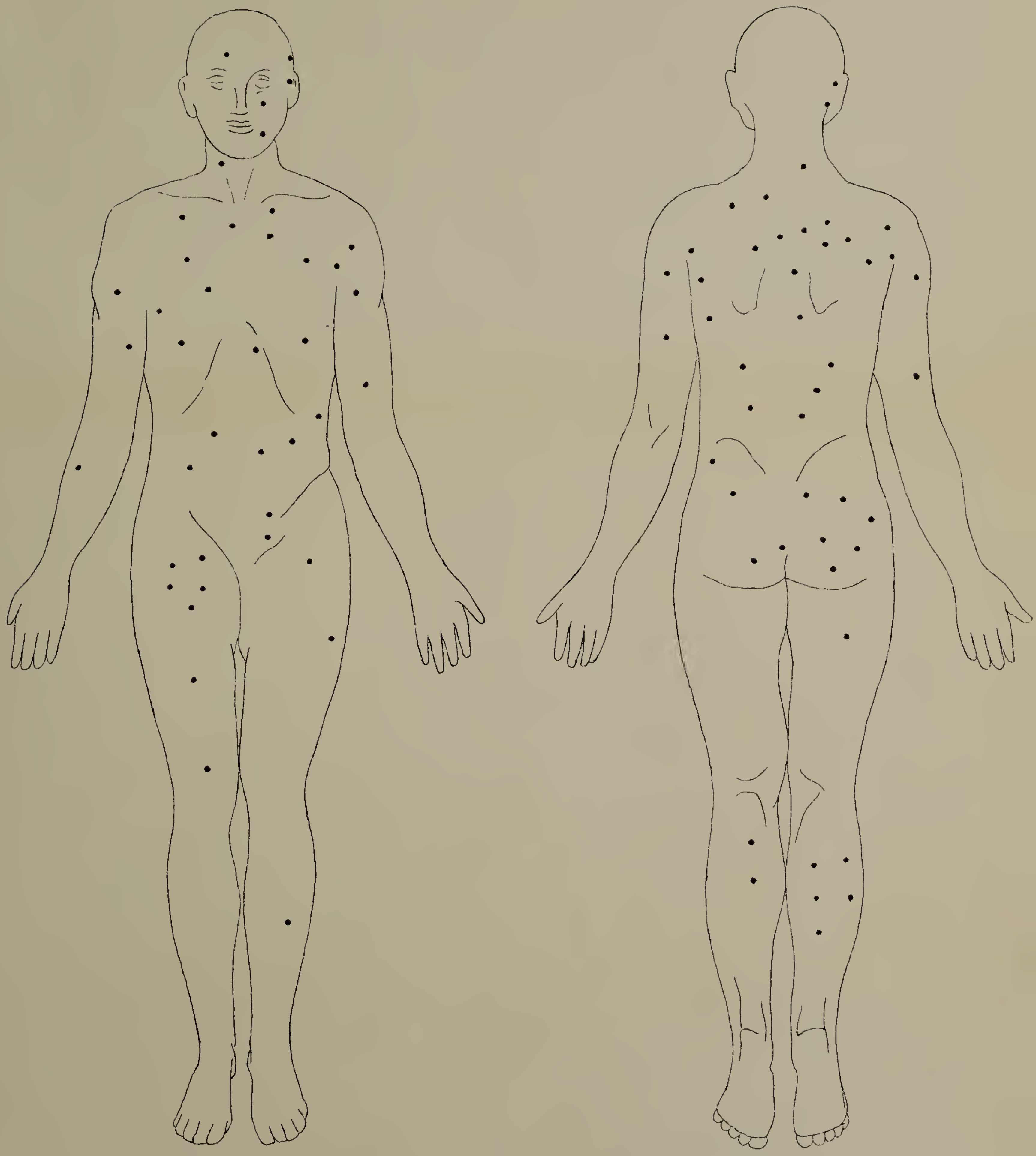
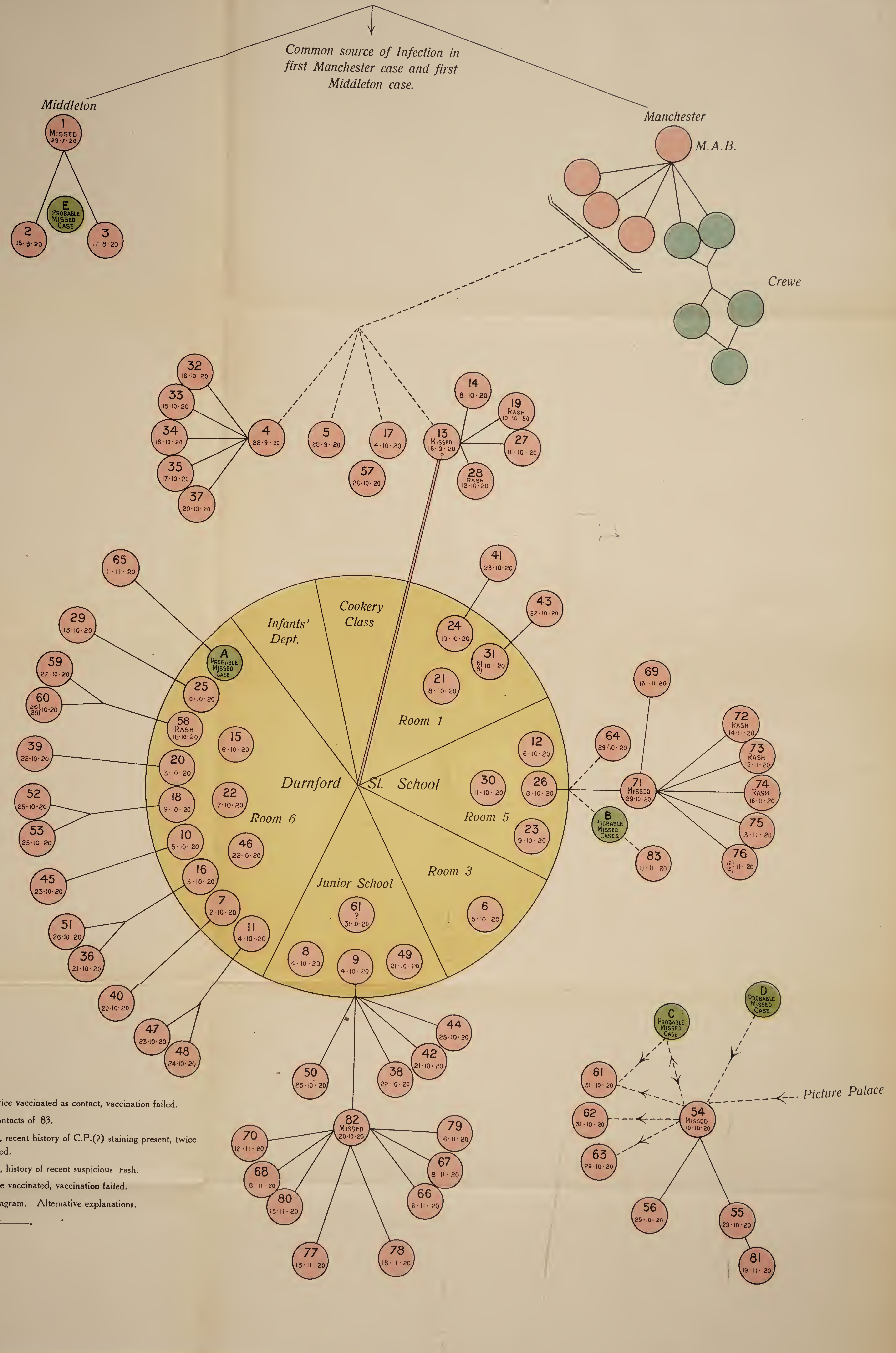


Diagram B.

SPREAD OF THE DISEASE.



A—Unvaccinated sister of 65, twice vaccinated as contact, vaccination failed.

B—Home contacts of 26, club contacts of 83.

C—Unvaccinated playmate of 54, recent history of C.P.(?) staining present, twice vaccinated, vaccination failed.

D—Unvaccinated playmate of 54, history of recent suspicious rash.

E—Unvaccinated sister of 1, twice vaccinated, vaccination failed.

61—This case appears twice in diagram. Alternative explanations.